Draft Amendment
to the
WATER QUALITY CONTROL PLAN
for the
NORTH COAST REGION
to
Update Water Quality Objectives

Draft Supplemental Environmental Document (SED)

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Executive Summary

This staff report presents the necessary information and findings to support the draft Water Quality Objectives (WQO) Update Amendment. The draft WQO Update Amendment was developed by North Coast Regional Water Quality Control Board (Regional Water Board) staff to update the Basin Plan by revising the Water Quality Objectives (Section 3) and Implementation Plans (Section 4) of the Basin Plan. Many of the water quality objectives described in Section 3 were developed in the 1970s or 1980s and have not been revised since. Some of these are outdated, with respect to the findings of current scientific literature.

The primary goals of the draft WQO Update Amendment are to develop a narrative water quality objective for groundwater toxicity objective, update the surface waters and groundwaters objectives for chemical constituents, update the surface water objectives for dissolved oxygen (DO), and clarify the process the Regional Water Board uses when narrative objectives are translated into numeric limits for use in permits, orders, or other actions.

To accomplish these goals staff proposes that:

1) The objectives for chemical constituents for surface water and groundwater be updated to reflect current scientific understanding and to more clearly apply to the protection of all beneficial uses;
2) A toxicity objective for groundwater be articulated, using the toxicity objective for surface water as a model for the explicit protection of human health;
3) The DO objectives be revised to: a) better protect sensitive aquatic organisms from depressed DO; b) better ensure that the natural pattern and range of DO variation is maintained in those waterbodies unable to meet the aquatic life-based objectives due to natural conditions; and c) reduce the possibility that natural variation in DO is erroneously identified as DO impairment leading to improper 303(d) listings;
4) Language be added to Section 3 to explain how numeric values are identified to implement narrative water quality objectives; and,
5) Language be added to Section 4 to describe the variety of tools the Regional Water Board uses when implementing water quality standards.

Currently, Regional Water Board staff establishes appropriate water quality criteria when issuing permits, orders, and other regulatory actions by using the authorities in the existing Basin Plan in combination with statewide policies such as the *Policy for Implementation of Toxic Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (State Implementation Plan or SIP); *Antidegradation Policy Resolution No. 68-16* (Res No. 68-16); and *Policy on Cleanup and Abatement* Resolution No. 92-49 (Res No. 92-49), and other established and relevant resources. Staff has developed this proposed WQO Update Amendment to make more explicit the responsibilities and authorities of the Regional Water Board with respect to the establishment and use of water quality objectives by prospectively incorporating MCLs, adding a narrative groundwater toxicity objective, and describing the process used to translate narrative objectives into numeric criteria.

The proposed amendment for DO is designed to update the existing aquatic life criteria to include protection against both acute and chronic effects of DO impairment. The proposed amendment also addresses the problems associated with Table 3-1 of the Basin Plan in which waterbody-specific objectives (WSOs) for DO are assigned to individually named waterbodies in the Region. The problems to be solved include: 1) a reliance on day time grab sample data to define the daily minimum condition, and an inconsistency in approach to the WSOs between waterbodies in the Klamath River Basin and those in the North Coastal Basin. The proposed solution to the problems associated with the WSOs for DO is to replace the WSOs with a natural conditions clause which requires that the natural pattern and range of ambient DO variability be maintained in those waterbodies which cannot, due to natural conditions, meet the aquatic life criteria.

This draft amendment seeks to clarify the longstanding procedures for implementing water quality objectives within the framework of the Basin Plan so as to provide regulatory transparency. The goal of the draft revisions is to elaborate on existing authorities so as to make clear and transparent the process staff has been using and will continue to use when identifying the most appropriate numeric threshold when protecting beneficial uses.

The actual draft language for Section 3 is included in Appendices A and C (strikethrough/underline copy and clean copy, respectively). Additionally the draft language for Section 4 is included in Appendices B and D (strikethrough/underline copy and clean copy, respectively). This staff report is organized into the following chapters:

1. Introduction
2. Existing Conditions
3. Draft Revisions to Basin Plan Section 3 (Water Quality Objectives)
4. Draft Revisions to Basin Plan Section 4 (Implementation Plans)
5. California Environmental Quality Act Analysis
6. Economic Considerations
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1. Introduction

This staff report presents the necessary information and findings to support the draft Water Quality Objectives (WQO) Update Amendment. The draft WQO Update Amendment was developed by North Coast Regional Water Quality Control Board (Regional Water Board) staff to update the Basin Plan by revising the Water Quality Objectives (Section 3) and Implementation Plans (Section 4) of the Basin Plan. The primary goals of the draft WQO Update Amendment are to:

- develop a narrative groundwater toxicity objective
- update the chemical constituents objectives for surface waters and groundwaters
- update the dissolved oxygen (DO) objectives, and
- clarify the process the Regional Water Board uses when narrative objectives are translated into numeric limits for use in permits, orders, or other regulatory actions.

The draft WQO Update Amendment language is appended to this staff report. Appendices A and B provide a strikethrough/underline version of the draft revisions to the Water Quality Objectives and Implementation Plans sections of the Basin Plan (Sections 3 and 4, respectively). Appendices C and D present the "clean version" of Sections 3 and 4 of the Basin Plan with the draft revisions incorporated. This staff report provides the information relative to the scope, need, and environmental impacts of the draft WQO Update Amendment necessary to support the Regional Water Board's consideration and adoption of the draft amendment.

1.1 Function and Framework of the Basin Plan

The Porter-Cologne Water Quality Control Act (Porter-Cologne) established the regional water board system and charged the boards with the primary responsibility for protecting water quality in the state.[1] Porter-Cologne also required that each regional water board formulate and adopt basin plans for all areas within its region. The Regional Water Board's Basin Plan is designed to provide a definitive program of actions to preserve and enhance water quality and protect beneficial uses of waters of the state in the Region and forms the basis for the Regional Water Board's regulatory programs. The Basin Plan also must be consistent with state policies and plans. The Basin Plan, including periodic updates, is approved by the State Water Resources Control Board (State Water Board), the Office of Administrative Law (OAL), and the United States Environmental Protection Agency (U.S. EPA), as appropriate.[2] Specifically, the Basin Plan:

1) Identifies beneficial uses for surface waters and groundwaters;
2) Sets narrative and numeric ambient water quality objectives that must be attained or maintained to protect beneficial uses;
3) Describes implementation programs that include specific prohibitions, action plans, and policies to achieve ambient water quality objectives; and
4) Describes surveillance and monitoring activities.

[1] Wat. Code § 13001.
[2] U.S. EPA approval is required for surface water standard actions.

Section 2 of the Basin Plan (Beneficial Uses) identifies the existing and potential beneficial uses of water in the North Coast Region, including uses that pertain to: human health (e.g., drinking water, recreation), commerce (e.g., industrial process water, hydropower), aquatic life (e.g., cold water habitat, spawning habitat), and ecological services (e.g., flood peak attenuation, water quality enhancement). Existing beneficial uses are those uses that were attained in a waterbody on or after November 28, 1975, for surface water protected under the Clean Water Act[3] and on or after October 24, 1968[4] for all other waters protected under Porter-Cologne. Potential beneficial uses are established for any of the following reasons:

1) The use existed prior to November 28, 1975 (or prior to October 24, 1968), but is not currently being attained;
2) Plans already exist to put the water to that use;
3) Conditions make such future use likely;
4) The water has been identified as a potential source of drinking water based on the quality and quantity available (see *State Water Board Resolution No. 88-63, Sources of Drinking Water Policy* described in Chapter 2 of this staff report);
5) Existing water quality does not support these uses, but remedial measures[5] may lead to attainment in the future; or
6) There is insufficient information to support the use as existing; however, the potential for the use exists and upon future review, the potential use may be re-designated as existing.

One of the functions of the Basin Plan is to designate beneficial uses for individual waterbodies or categories of waters. Regional water boards are required to protect beneficial uses of water[6] if they exist in a waterbody, even if they are not currently listed in Table 2-1 in the Basin Plan.[7] Table 2-1 of the Basin Plan identifies the designated beneficial uses of individually named hydrologic areas, as well as categories of waters. The beneficial uses of the North Coast Region include:

MUN	Municipal and Domestic Supply
AGR	Agricultural Supply
IND	Industrial Service Supply
PRO	Industrial Process Supply
GWR	Groundwater Recharge
FRSH	Freshwater Replenishment
NAV	Navigation
POW	Hydropower Generation
REC-1	Water Contact Recreation

[3] Date of the first Water Quality Standards Regulation published by U.S. EPA (November 28, 1975) 40 CFR 131.3 (e).
[4] *Asociación de Gente Unida por el Agua v. Central Valley Regional Water Quality Control Board* (2012) 210 Cal.App.4th 1255 (*AGUA)*decision concludes that the antidegradation baseline is 1968 of the best water quality that has existed since 1968
[5] Remedial measures include implementation of effluent limits required under Section 301(b) and 306 of the CWA, and implementation of cost-effective and reasonable best management practices for nonpoint source control. 40 CFR 131.10(d).
[6] Wat. Code § 13241.
[7] 40 CFR 131.3 .

REC-2	Non-Contact Water Recreation
COMM	Commerical and Sport Fishing
WARM	Warm Freshwater Habitat
COLD	Cold Freshwater Habitat
ASBS	Preservation of Areas of Special Biological Significance
SAL	Inland Saline Water Habitat
WILD	Wildlife Habitat
RARE	Rare, Threatened, or Endangered Species
MAR	Marine Habitat
MIGR	Migration of Aquatic Organisms
SPWN	Spawning, Reproduction, and/or Early Development of Fish
SHELL	Shellfish Harvesting
EST	Estuarine Habitat
AQUA	Aquaculture
CUL	Native American Culture
FLD	Flood Peak Attenuation/Flood Water Storage
WET	Wetland Habitat
WQE	Water Quality Enhancement
FISH	Subsistence Fishing

Most of the beneficial uses described are applicable to surface waters in the North Coast Region. Beneficial uses for surface waters are generally designated for individually named hydrologic units. Groundwaters, on the other hand, are identified as a single category of waters and designated for MUN, AGR, IND, PRO, AQUA, and CUL beneficial uses. Where groundwater and surface water are connected, the designated beneficial uses of the surface water may also apply to groundwater.

Section 3 of the Basin Plan (Water Quality Objectives) identifies ambient water quality objectives that the Regional Water Board has adopted for the protection of beneficial uses of water. These objectives describe the characteristics of waterbodies necessary to allow the beneficial use of those waterbodies and form the basis for establishing numeric effluent (or discharge) limits or cleanup levels in Regional Water Board permits, orders, or other regulatory actions. Further, anyone discharging or threatening to discharge a waste to a water of the state must comply with the provisions of the Basin Plan, in most cases seeking specific authorization from the Regional Water Board for the right to discharge. Where those discharges have the potential to impact ambient conditions, water quality objectives will apply.

Any regulatory agency, whether local, state or federal, with authority over an activity that could affect water quality, has an obligation to consider the Basin Plan and its water quality objectives during its decision-making process. This is the case for a wide range of potential projects including: building projects, road construction, logging, water withdrawal, groundwater injection, etc. All controllable water quality factors must conform to the water quality objectives contained in the Basin Plan. For further discussion see Section 2.2 Existing Regulatory Framework.

For the purposes of this draft proposed amendment, the groundwater and surface water beneficial uses identified in the Basin Plan adequately represent past, present, and probable future beneficial uses. The draft proposed groundwater toxicity objective, the revised chemical constituents objectives for surface waters and groundwaters, and the revised dissolved oxygen objectives for surface waters are designed to protect these beneficial uses. The draft proposed amendment also includes significant introductory language that describes the means by which applicable numeric values are determined that implement narrative water quality objectives in a manner sufficient to protect the most sensitive beneficial uses of a given waterbody. As such, the draft proposed objectives are fully protective of surface water and groundwater beneficial uses and reflect existing practices when implementing water quality objectives through permits, orders or other regulatory actions.

1.2 Triennial Review List of Basin Planning Priorities

Section 13240 of the Porter-Cologne Water Quality Control Act and Section 303 (c)(1) of the federal Clean Water Act require a review of basin plans at least once each three-year period to keep pace with changes in regulation, new technologies, policies, and physical changes within the region.

The Regional Water Board is responsible for reviewing the Basin Plan, and is required to: 1) identify those portions of the Basin Plan that are in need of modification or new additions; 2) adopt standards as appropriate; and 3) recognize those portions of the Basin Plan that are appropriate as written. The Regional Water Board solicits written and oral public input, which it considers prior to adopting a prioritized list of basin planning projects. The highest priority projects are included on the "short list" which establishes the workplan of the Regional Water Board's Planning Unit for the next three-year period.

A triennial review of the Basin Plan was last conducted in 2011 resulting in the Regional Water Board's adoption of Resolution No. R1-2011-0091, including as an attachment to the *Proposed 2011 Triennial Review List of Potential Basin Plan Amendments.*[8] The WQO Update Amendment is included as part of Item #3 and #4 on the 2011 Triennial Review. In total, the projects included on the short list in the 2011 triennial review are:

1. TMDL-related projects in the Elk River, Freshwater Creek, Eel River, Mattole River, Navarro River, Russian River, and the Laguna de Santa Rosa;
2. A Temperature Implementation Policy;
3. Water quality objectives for groundwater and surface water, including new and revised programs of implementation;
4. Dissolved oxygen water quality objectives for free flowing streams, wetlands, and lakes; and,
5. An Aquatic Ecosystem Restoration Policy.

[8] http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/111013_tr/100929_res_11-0091_trirev.pdf

1.2.1 Planning History of Chemical Constituents and Groundwater Toxicity Objectives

For a number of years, the Regional Water Board has ranked the development of a groundwater toxicity objective as a high priority during each triennial review process. During the 2004 Triennial Review of the Basin Plan, the Regional Water Board included direction that a Basin Plan amendment be developed that would clearly articulate the process used by the Board in translating narrative water quality objectives into numeric limits for use in permits, orders, or other regulatory actions as appropriate. The Regional Water Board also directed staff to develop minor editorial (non-substantive) revisions to the existing water quality objectives for groundwater and surface water to update outdated references, etc.

As part of the 2007 Triennial Review, these issues were combined into one task to facilitate development of a comprehensive proposal and to aid in outreach and solicitation of public comment. Staff determined that the multitude of actions required to complete this task would be most appropriately divided into two distinct Basin Plan amendments. The actions identified in this staff report represent the first phase of this work. This first phase focuses on revisions to water quality objectives and the addition of new language that clarifies how narrative objectives are translated into numeric limits. The second phase will focus on revisions to Basin Plan Section 4 (Implementation Plans) to include statewide groundwater protection policies (e.g., the State's Recycled Water Policy) and update the implementation program for the discharge of waste to land (e.g., Groundwater Protection Strategy amendment).

The 2011 Triennial Review List, adopted on September 29, 2011, identifies the two phases of this work as task three of thirty-one tasks. Following the Regional Water Board's consideration of the WQO Update Amendment, staff will begin development of the Groundwater Protection Strategy amendment.

The Regional Water Board held a workshop at its regularly scheduled Board meeting on March 15, 2012 on the draft WQO Update Amendment. Oral and written public comments on the draft amendment were also solicited. Commenters raised a number of issues which staff addressed in a revised draft amendment package released for public review on February 21, 2013 in preparation for the adoption hearing scheduled before the Regional Water Board for June 13, 2013. Significant public comments were received during this public comment period which necessitated a postponement of the scheduled adoption hearing and additional refinement of the draft amendment package. This draft Substitute Environmental Document (SED) consists of this Staff Report and response to comments documents to address public comments received to date, most specifically expanding the California Environmental Quality Act (CEQA) analysis to address potentially significant environmental impacts resulting from implementation of the proposed amendment.

1.2.2 Planning History of Dissolved Oxygen Objectives

The Regional Water Board directed staff in its 2007 Triennial Review of the Basin Plan to develop a proposal for the revision of the water quality objectives for dissolved oxygen (DO) as contained in the Basin Plan. Two CEQA scoping meetings were held in the fall of 2008, one in Santa Rosa and one in Weaverville. A Scoping Document was presented and public comments solicited. The proposed revision of the existing DO objectives was intended to apply throughout the North Coast Region.

In the spring of 2009, a draft staff report was written, based in part on scoping comments received. It was submitted to two peer reviewers for their scientific review and comment. The Regional Water Board received peer review comments later in the spring of 2009 and began revision of the document for public review.

In the meantime, the schedule for the Klamath River Total Maximum Daily Load (TMDL) for DO (and other parameters) required the immediate review of the Site Specific Objectives (SSOs) for DO in the Klamath mainstem. Staff turned its attention to the Klamath SSOs for DO, determined the need for revision and issued a proposal to amend them for public review during the summer of 2009. The proposal for the revision of the Klamath SSOs for DO adheres to the recommendations as provided by the peer reviewers of the regionwide proposal. The SSOs for DO in the Klamath River was adopted by the Regional Water Board in March 2010, adopted by the State Water Resources Control Board in September 2010, and approved by U.S. EPA Region 9 in December 2010.

This draft proposed amendment would apply to the whole region the revised peer reviewed DO objective schema used to assess and recalculate the SSOs for DO in the Klamath mainstem. As described in Chapter 3, this includes updates to the aquatic life-based objectives and a process for calculating SSOs for DO based on natural conditions.

1.3 Goals of the Draft WQO Update Amendment

The primary goals of the draft WQO Update Amendment are to: 1) make clear and transparent the process that staff uses when translating narrative water quality objectives into numeric values protective of beneficial uses, particularly with respect to chemical constituents; and 2) amend the Basin Plan's water quality objectives to support the protection of human health and aquatic ecosystems. To accomplish these goals staff proposes that:

1) The objectives for chemical constituents for surface water and groundwater be updated to reflect current scientific understanding, more clearly apply to the protection of all beneficial uses, and more flexibly remain current;
2) A toxicity objective for groundwater be articulated, using the toxicity objective for surface water as a model;
3) The DO objectives be revised to: a) better protect sensitive aquatic organisms from depressed DO; b) better ensure that the natural pattern and range of DO variation is maintained in those waterbodies unable to meet the aquatic life-based objectives due to

natural conditions; and c) reduce the possibility that natural variation in DO is erroneously identified as DO impairment leading to improper 303(d) listings;
4) Language be added to Section 3 to explain how numeric values are identified to implement narrative water quality objectives; and,
5) Language be added to Section 4 to describe the variety of tools the Regional Water Board uses when implementing water quality standards.

1.3.1 Chemical Constituents and Groundwater Toxicity

The existing water quality objectives for chemical constituents do not reflect current scientific understanding for all parameters. The objectives for chemical constituents apply to surface water and groundwater, both of which can support domestic and municipal supply and also support numerous other beneficial uses. The specific numeric objectives for chemical constituents contained in the Basin Plan are the drinking water standards developed by the California Department of Public Health (now the State Water Board Division of Drinking Water) and described in the California Code of Regulations, Title 22, at the time the objectives were adopted in 1975 and modified in 1993, which are now outdated.

The existing objective for chemical constituents is both narrative and numeric. The first portion applies MCLs as the upper most limits to waters with the municipal and domestic water supply (MUN) beneficial use. The section portion is narrative and protects from adverse impacts to the agricultural beneficial use. The third portion applies waterbody-specifc objectives, as listed in Table 3-1, for specific conductance, total dissolved solids (TDS), DO, pH, hardness, and boron.

Therefore, the draft revisions to the objectives for chemical constituents include:

1. Revising the narrative objectives for chemical constituents to clearly apply to the protection of all beneficial uses, not just AGR.
2. Adding language regarding the prevention of nuisance, as required in Porter-Cologne.
3. Deleting the outdated Table 3-2, *Inorganic, Organic, and Fluoride Concentrations Not to be Exceeded in Domestic or Municipal Supply*.
4. Prospectively incorporating the Primary and Secondary MCLs listed in California Code of Regulations, Title 22 as the minimum water quality objectives for chemical constituents to protect the MUN beneficial use.

One of the areas requiring greater clarity is that although the Basin Plan includes objectives for chemical constituents for surface water and groundwater protection, there are other plans and policies that must be considered when regulating chemical constituents to protect beneficial uses. For this reason reference to the State Water Board *Policy for Implementation of Toxic Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (SIP) is included as part of the proposed amendment. The SIP describes the application of the National Toxics Rule (NTR) and California Toxic Rule (CTR) for the protection of human and aquatic life receptors in surface water within National Pollutant Discharge Elimination System (NPDES) Permits. Similarly, the State Water Board adopted

Resolution No. 92-49 *Policies and Procedures for Investigation and Cleanup and Abatement of Discharges Under Water Code Section 13304,* which directs groundwater assessment and cleanup activities. It requires that groundwater quality be returned to background conditions, where possible, in keeping with the requirements of the State Water Board Resolution No. 68-16, *Policy with Respect to Maintaining High Quality of Water* in California (Antidegradation Policy). Where not possible, Resolution No. 92-49 requires that cleanup activities result in the "best water quality which is reasonable…considering all demands being made and to be made on those waters and the total values involved, beneficial and detrimental, economic and social, tangible and intangible…" That is to say that the Regional Water Board is authorized via Porter-Cologne and the plans and policies of the State Water Board to implement controls with respect to constituents that have the potential to cause groundwater toxicity. This draft proposed amendment includes the addition of a narrative groundwater toxicity objective as a mechanism to more explicitly implement numeric criteria controlling toxicity in groundwater, as otherwise required under State law.

WATER CODE SECTION 106.3

In compliance with Water Code section 106.3, it is the law of the State of California that every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes. It is now known as the Human Right to Water (HRTW) law. This draft proposed Basin Plan amendment advances the HRTW law by updating the water quality objectives for chemical constituents, adding a groundwater toxicity objective and describing the translation of narrative water quality objectives into numeric limits to protect all beneficial uses including domestic and municipal water supply (MUN).

1.3.2 Dissolved Oxygen

This draft proposed amendment includes the revision of the region-wide DO objectives, including consideration of appropriate DO requirements in flowing waters, ephemeral waters, lakes, reservoirs, wetlands, and estuaries. The draft amendment is designed to update the existing aquatic life-based objectives to include protection against both acute and chronic effects of DO impairment. The draft amendment also addresses problems associated with Table 3-1 of the Basin Plan in which site-specific objectives (SSOs) for DO are assigned to individually named waterbodies in the Region. The problems associated with the SSOs that are to be solved include: a reliance on daytime grab sample data to define the daily minimum condition, and an inconsistency in approach to the SSOs between waterbodies in the Klamath River Basin (i.e., the Klamath River and all other waterbodies north of the California-Oregon border) and those in the North Coast Basin (i.e., all waterbodies south of the Klamath River down to San Antonio Creek at the border of Marin and Sonoma counties). Further discussion on the proposed DO amendment is presented in Chapter 3 of this Staff Report.

1.4 Regulations That Apply to Adopting Water Quality Objectives

Federal regulations require states to adopt narrative or numeric water quality criteria to protect designated uses (40 CFR §131.11(a)(1).) The State's Porter-Cologne Water Quality

Control Act refers to water quality criteria as water quality objectives and designated uses as beneficial uses. The State's terminology is used here.

California Water Code section 13050, subdivision (h) defines water quality objectives as: "…the limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area."

Specific to the adoption or revision of water quality objectives and pursuant to Water Code section 13241, when adopting water quality objectives, the Regional Water Board is required to consider the following elements. Within the description of each element below, the reader is pointed to the location within the staff report where full consideration of the element is presented.

(a) *Past, present, and probable future beneficial uses of water.*
Existing and potential beneficial uses of waters in the North Coast Region are identified in the Basin Plan (Table 2-1). Surface water beneficial uses are identified for each hydrologic unit in the region. In addition, beneficial uses are identified for broad categories of waters including bays, estuaries, minor coastal streams, ocean waters wetlands, and groundwaters. For more detail see Section 1.1 of this Staff Report;

(b) *Environmental characteristics of the hydrographic unit under consideration, including the quality of water available thereto*.
The draft Basin Plan amendment will revise objectives throughout the entire North Coast Region and all hydrographic units within its boundary. A description of the environmental characteristics and available quality of waters in the region is presented in Chapter 2 of this Staff Report;

(c) *Water quality conditions that could reasonably be achieved through the coordinated control of all factors which affect water quality in the area*.
Key pollution threats to groundwater and surface water in the region include industrial wastes, leaking petroleum tanks, septic leakage, urban and agricultural runoff, forestland and urban road runoff, and the disposal of waste to land and to surface waters. The use of best achievable technology in many cases has proven to prevent or remediate pollution, which in turn supports beneficial uses. Additionally, several areas through the region are high quality waters. For additional discussion see Section 2.3 of this Staff Report;

(d) *Economic considerations*
When adopting water quality objectives the Regional Water Board must consider the cost of compliance measures and provide information on the potential sources of funding. Additionally, economics must be considered if adverse economic impacts will result in an adverse physical impact on the environment. For a list of compliance measure costs and potential sources of funding see Chapter 6 of this Staff Report;

(e) *The need for developing housing within the region.*
The availability of consumable and usable water supplies is a necessary component of the ability to develop housing. Protecting all the beneficial uses

associated with water supply will continue to enable potential housing development. For additional information see Population and Housing discussions in Chapters 2 and 5 of this Staff Report;

(f) *The need to develop and use recycled water*.
Recycled water use has been developed and implemented throughout the Region as a means to offset potable and non-potable water uses and decrease water demand. Implementing recycled water projects in a manner protective of beneficial uses is a significant goal for the State of California. For additional discussion see Section 2.1.9 of this Staff Report; and

(g) *The Program of Implementation (Wat. Code, §13242)*
When adopting objectives the Regional Water Board must consider how the water quality objectives are achieved. This includes a description of actions necessary to take, recommendations to any entity private or public, a time schedule, and a description of surveillance (i.e., monitoring and reporting) to determine compliance. For additional discussion see Section 2.2 of this Staff Report.

2 Existing Conditions

The following chapter describes the baseline physical setting, environmental characteristics of the hydrologic units and existing regulations of the North Coast Region. Section 2.1 below describes the environmental setting for the region and Section 2.2 below generally describes the current regulatory framework associated with implementation of the objectives for chemical constituent, toxicity, and dissolved oxygen. This chapter generally describes these existing conditions and does not describe all existing laws, regulations and policies under the purview of the Regional Water Board. The descriptions of the regulatory programs are specific to the water quality objectives being discussed. For example the cleanup program is discussed as it relates to the objectives for chemical constituents and groundwater toxicity, while the timber harvest program is discussed in relation to the objective for DO.

2.1 Environmental Setting

The environmental setting of a proposed project establishes the baseline condition against which potential environmental impacts of the proposed project are compared. The proposed project is designed to address existing or potential impacts to water quality within the Region with the goal of improving water quality for the protection of human health, recreation, aquatic life, and ecosystem function. As a programmatic analysis, this chapter provides a general description of the Region, highlighting the key factors identified in the CEQA analysis including: aesthetics, agricultural resources, air quality, biological resources, cultural resources, geology and soils, greenhouse gas emissions, hazards and hazardous materials, hydrology and water quality, land use and planning, mineral resources, noise, population and housing, public services, recreation, transportation/traffic, and utilities and service systems.

The North Coast Region comprises all basins including Lower Klamath Lake and Lost River Basins draining into the Pacific Ocean from the California-Oregon state line southerly to the southerly boundary of the watershed of the Estero de San Antonio and Stemple Creek in Marin and Sonoma Counties[1]. The region is divided into two natural drainage basins: 1) the Klamath River sub-basin which drains the Cascade Range Geomorphic Province, the Modoc Plateau Geomorphic Province and the Klamath Mountain Geomorphic Province and 2) the North Coastal sub-basin which drains the Coast Range Geomorphic Province. The North Coast Region covers all of Del Norte, Humboldt, Trinity, and Mendocino counties, major portions of Siskiyou and Sonoma counties, and small portions of Shasta, Glenn, Lake, and Marin counties.

The North Coast Region encompasses a total area of approximately 19,390 square miles (mi^2), including 340 miles of scenic coastline, 362 miles of designated Wild and Scenic Rivers, 416 mi^2 of National Recreation Areas, and 1,627 mi^2 of National Wilderness Areas,

[1] Wat. Code § 13200 subdivision (a).

as well as urbanized, forested, and agricultural areas. The region is characterized by steep, mountainous forested terrain with distinct temperature and precipitation zones. The mountain crests, which form the eastern boundary of the region, are about 6,000 feet in elevation with a few peaks higher than 8,000 feet. Much of the region is mountainous and rugged; only 13 percent of the land is classified as valley or mesa, and more than half of that is in the higher- elevation northeastern part of the region in the upper Klamath River Basin. The coast is mild, foggy and produces moderate variations in seasonal temperatures. Coastal redwoods and Douglas fir-tanoak forests dominate this landscape. Inland areas outside of the coastal influence undergo more extreme seasonal temperature variation with seasonal maximums exceeding 100 ºF. Oaks and pines interspersed with grasslands and chaparral are more common inland.

The U.S. Geological Survey (USGS) published in 1998 a report entitled "The Status and Trends of the Nation's Biological Resources." What follows are excerpts from this report for northwestern California[2].

> "Northwestern California has the wettest, most consistent climate in the state. It is composed mainly of the coastline and several metamorphic mountain ranges, including the Klamath Mountains and the north Coast Ranges. The coastal region, from the Oregon border south to Bodega Bay, is dominated by areas of coastal prairie, some coastal marsh, closed-cone pine and cypress forests on poor soils, and grand fir–Sitka spruce forests on better soils (Hickman 1993). Many of the cypress groves are associated with chaparral, rock outcrops, or serpentine soils. The closed-cone pines are generally small in stature and, like the cypresses, are associated with chaparral, fire, and shallow, acidic, nutrient-poor soils, often serpentine or sandstone. These pines are short-lived (50–100 years), and their seeds can only germinate on bare mineral soils. Like the cypresses, the closed-cone pines require fire for successful reproduction. Knobcone pine is the most widespread of the closed-cone pines, ranging nearly the length of the state."
>
> "The Klamath Mountains are geologically old and support mixed evergreen forests of Douglas-fir, ponderosa pine, and sugar pine, with mountain hemlock, white fir, and chinquapin found at higher elevations. Serpentine soils are common in the Klamath Mountains. On the west side, Douglas-fir–hardwood forests grow at low elevations, giving way at higher elevation to white fir–Douglas-fir forests, white fir–California red fir forests, and finally to mountain hemlock–California red fir at the highest elevations. East and south of the highest ridges, the climate is drier and more continental. At low

[2] http://www.nwrc.usgs.gov/sandt/SNT.pdf accessed August 16, 2013.

elevations, forests are dominated by ponderosa pine, which is replaced by white fir–pine forests at higher elevations, then red fir–white fir forests, and finally mountain hemlock–red fir, with whitebark pine occurring at the highest elevations. The Klamath Mountains have a high floristic diversity, in part because they have acted as refugia supporting many endemics and relict species, including Pacific silver fir, subalpine fir, Alaska-cedar, Brewer spruce, Engelmann spruce, and foxtail pine. The complex vegetation patterns in the Klamath Mountains seem based primarily on differences in soils and secondarily on elevation and soil moisture (Sawyer and Thornburgh 1977)."

"The northern Coast Ranges occur immediately south of the Klamath Mountains. Coast Range forests do not include hemlock and have noble or red fir replacing grand fir, with rhododendron replacing chinquapin in the understory. Hardwoods increase in frequency on the drier slopes inland. The outer northern Coast Ranges, those farthest to the west, receive a great deal of rain (Hickman 1993). Riparian areas and north-facing slopes of the Coast Range fog belt support redwood forests…, which thrive where coastal fog is frequent. Redwood is a California endemic and is the tallest (112 meters) and fastest-growing tree in the world (Zinke 1977); one of these trees may live more than 2,000 years (Bakker 1972). Although redwoods were common in the Tertiary over much of North America, they are now restricted to the fog belt of maritime central and northern California. Proximity to the sea moderates temperatures, and fog helps prevent evapotranspiration (moisture loss from leaves). Fog drip contributes considerable moisture to the soil during the otherwise dry summer season (18–30 centimeters per year; Zinke 1977). The continuous moisture enables redwood forests to be home to a number of amphibians, including ensatinas, ocelot-spotted giant salamanders, tailed frogs, and seep salamanders, as well as the more common banana slugs (Bakker 1972)."

"Douglas-fir is often a codominant in redwood forests, becoming established after fires, and tanoak, California bay, madrone, and western hemlock are common understory trees where enough light penetrates the canopy (Zinke 1977). Redwood is a valuable timber tree because of its size and because of the wood's unique resistance to rot. More than 85% of the old-growth coast redwood forests has been logged, but much of the original distribution of about 810,000 hectares remains in second-growth redwood forests of varying ages. Second-growth redwood forests support most of the same native vascular plants as old-growth forests, but habitat for species that depend on old-growth forests—such as spotted owls, marbled murrelets, some arthropods, mollusks, and canopy lichens—has been greatly reduced (U.S. Fish and Wildlife Service 1995a). Logging of redwood continues, although most old-growth stands are now protected in state parks and in Redwood National Park."

"Drier slopes of the Coast Ranges support mixed-evergreen and mixed-hardwood forests, whereas montane forests of subalpine fir and pines are found at higher elevations. Vegetation on the highest peaks is similar to that found at high elevations in the Sierra Nevada; peaks above 1,500 meters are treeless and experience heavy winter snows. Summers are hot and rainfall is low in the inner northern Coast Ranges, especially on eastern slopes in the rain shadow of the peaks. Serpentine soils are common, and dry eastern slopes support chaparral and pine–oak woodland. (Hickman 1993)."

2.1.1 Aesthetics

The North Coast Region is a predominantly rural region with numerous outstanding natural features and scenic vistas, including dramatic coastline, rolling hills, mountains, forests, rivers, wetlands, and estuaries. Hundreds of miles of highway cross through the North Coast Region. But, only a total of 52 miles have been designated officially as State Scenic Highway. This includes 12 miles of Highway 101 as it passes through Redwood State Park in Del Norte County; 12 miles of Highway 12 east of Santa Rosa in Sonoma County, and 28 miles of Highway 116 west of Santa Rosa in Sonoma County. Much of the rest of the highway system in the region is eligible as State Scenic Highway but has not been designated. These are listed in Table 2-1.

Table 2-1 Highways Eligible but not Designated as State Scenic Highways[3]

County	Highways
Del Norte	101 north of Crescent City, 169, 197, and 199
Glenn	None
Lake	20, 29, and 281
Mendocino	1, 20 and 101
Modoc	139 and 299
Siskiyou	96
Sonoma	1 and portions of 12
Trinity	2 and 299

As a general matter, light pollution resulting from outdoor lighting is restricted to the urban areas around Humboldt Bay from McKinleyville to Fortuna, Fort Bragg, Willits, Ukiah, and the greater Santa Rosa area from Windsor to Cotati. But of course, light pollution may be locally present wherever there are multiple outdoor lights.

[3] http://www.dot.ca.gov/hq/LandArch/scenic_highways/, accessed 8/16/13.

Any project implemented under this proposed program should be designed to avoid, minimize and mitigate any potential impact to aesthetics.

2.1.2 Agriculture

The predominant land uses in the North Coast Region are in the agricultural sector, including farming, ranching and timber production.

The California State Department of Conservation (Conservation) produces maps of counties with Prime Farmland, Unique Farmland, and Farmland of Statewide Importance (agricultural lands of special significance). These are farmlands that based on their soil characteristics are especially well suited for agricultural production. Conservation has produced maps for Modoc, Siskiyou, Mendocino, and Sonoma counties. These maps indicate agricultural lands of special significance predominantly concentrated in: 1) the Tule Lake region in Modoc County; 2) the Scott Valley, Shasta Valley, and upper Klamath River Valley in Siskiyou County; 3) Round Valley, Potter Valley, Eden Valley, Anderson Valley and the upper Russian River Valley in Mendocino County; and 4) Alexander Valley, Dry Creek Valley, and the Laguna de Santa Rosa in Sonoma County.

Conservation also defines areas of grazing land, based on certain environmental characteristics. Mendocino County is identified as predominantly grazing land. Sonoma County is a patchwork of farm land and grazing land. Modoc and Siskiyou counties are predominantly National Forest, interspersed with farmland and grazing land.

The U.S. Forest Service (USFS) manages lands encompassing approximately 56% of the North Coast Region (6,889,419 acres) spread between two USFS Regions and six national forests:

1. USFS Region 5 (Pacific Southwest Region), manages all or a portion of the following National Forests: Modoc National Forest, Klamath National Forest, Shasta/Trinity National Forest, Six Rivers National Forest, and Mendocino National Forest. These Forests comprise about 6,793,819 acres of the North Coast Region.

2. USFS Region 6 (Pacific Northwest Region) manages a portion of the Rogue River-Siskiyou National Forest, accounting for approximately 95,600 acres of the North Coast Region.

Private timber land accounts for a substantial amount of the region's land area, including lands managed for industrial and non-industrial timber production. The California Board of Equalization reports a total harvest from counties of the North Coast Region of 575,900 million board feet or 575,900,000 board feet in 2012. This is more than 40% of the timber harvested in the state.

Any project implemented under this proposed program should be designed to avoid, minimize and mitigate any potential impact to agriculture.

2.1.3 Air Quality

According to the California Air Resources Board (Air Board), the North Coast Region contains 3 separate, designated air basins. These are:

1. North Coast Air Basin encompassing Del Norte, Humboldt, Mendocino, Trinity, and substantial portions of Sonoma counties;
2. Northeast Plateau Basin encompassing Modoc, Lassen, and Siskiyou counties; and
3. Lake County Air Basin

The southern portion of Sonoma County is contained in the Bay Area Air Basin.

The pollutants of concern to air quality include: particulate matter (PM), ozone, nitrogen dioxide, sulfates, carbon monoxide, sulfur dioxide, visibility reducing particles, lead, hydrogen sulfide, and vinyl chloride. Statistics for ozone, particulate matter, carbon monoxide, nitrogen dioxide, and hydrogen sulfide are readily available for the 3 air basins within the North Coast Region, and Sonoma County, as shown in Table 2-2.

Ozone, an important ingredient of smog, is a highly reactive and unstable gas capable of damaging the linings of the respiratory tract. This pollutant forms in the atmosphere through complex reactions between chemicals directly emitted from vehicles, industrial plants, and many other sources. Key pollutants involved in ozone formation are hydrocarbon and nitrogen oxide gases. Particulate matter (PM) is a complex mixture of tiny particles that consists of dry solid fragments, solid cores with liquid coatings, and small droplets of liquid. These particles vary greatly in shape, size and chemical composition, and can be made up of many different materials such as metals, soot, soil, and dust. Particles 10 microns or less in diameter are defined as "respirable particulate matter" or "PM 10." Fine particles are 2.5 microns or less in diameter (PM 2.5) and can contribute significantly to regional haze, reduction of visibility, and respiratory illness. Carbon monoxide (CO) is a colorless, odorless gas. It results from the incomplete combustion of carbon-containing fuels such as gasoline or wood, and is emitted by a wide variety of combustion sources. Sulfur dioxide (SO_2) is a gaseous compound of sulfur and oxygen. SO_2 is formed when sulfur-containing fuel is burned by mobile sources, such as locomotives, ships, and off-road diesel equipment. SO_2 is also emitted from several industrial processes, such as petroleum refining and metal processing. Hydrogen sulfide (H_2S) is a colorless gas with the odor of rotten eggs. It is formed during bacterial decomposition of sulfur-containing organic substances. Also, it can be present in sewer gas and some natural gas, and can be emitted as the result of geothermal energy exploitation.

Table 2-2 2012 Air Quality Statistics for the 3 Air Basins, and Sonoma County, contained within the North Coast Region[4]

	North Coast Air Basin	Sonoma County	Northeast Plateau Air Basin	Lake County Air Basin
Ozone, # of days > 1-hour CA standard	1	0	0	2
Ozone, # of days > 8-hour CA standard	0	0	1	3
PM2.5, # of days > 24-hour Nat'l standard	0	0	0	0
PM10, # days > 24-hour CA standard	0	*	0	0
Carbon Monoxide, # of days > CA standard	0	*	*	*
Nitrogen Dioxide, # of days > CA standard	0	0	*	*
Hydrogen Sulfide, # of days > CA standard	*	*	*	0

*Insufficient data to calculate

As indicated in Table 2-2, the air quality in the North Coast Region is exceptionally good. The California Air Pollution Control Officers Association reports that none of the counties within the North Coast Region had any days in 2012 in which overall air quality was "unhealthy" and all had" good" overall air quality for an average of 349 days of the year (CAPCOA 2013). With respect to ozone, the numbers of exceedences indicated in Table 2-2 are among the lowest of any of the air basins in the state.

Any project implemented under this proposed program should be designed to avoid, minimize and mitigate any potential impact to air quality.

2.1.4 Biological Resources

The mission of the Regional Water Board is to develop and implement water quality standards and programs of implementation designed to restore and maintain the beneficial uses of water within the region. In the North Coast Region, some of the beneficial uses of water that often drive the water quality protection efforts of the agency are Cold Freshwater Habitat (COLD); Spawning, Reproduction, and Early Development (SPWN); Migration of Aquatic Organisms (MIGR); and Rare, Threatened or Endangered Species (RARE). The water quality programs designed to protect these beneficial uses, in turn, are most often driven by the habitat requirements of salmonids.

[4] http://www.arb.ca.gov/adam/topfour/topfour1.php, accessed on January 21, 2014.

Salmonidae are a family of aquatic vertebrates that during the freshwater portion of their life cycle require cold, clear, well-oxygenated freshwater, free of excessive fine sediment or obstructions to migration. As such, they are often recognized as indicators of watershed health, where populations are stable. Historically, they were abundant in watersheds of the North Coast Region. Today, populations of several Salmonidae species are listed by federal and state wildlife agencies as threatened or endangered by extinction. Species listed in some or all watersheds of the North Coast Region include: Chinook salmon, coho salmon, and steelhead trout. The proposed program is designed, in part, to protect the COLD, SPWN, MIGR, and RARE beneficial uses.

The Regional Water Board designs its water quality programs to protect other beneficial uses associated with the region's biological resources as well, including:

- Warm Freshwater Habitat (WARM)
- Estuarine Habitat (EST)
- Wildlife Habitat (WILD)
- Preservation of Areas of Special Biological Significance (ASBS)
- Wetland Habitat (WET)

The North Coast Region includes numerous threatened and endangered faunal and floral species (T&E species). The presence and disposition of T&E species must be evaluated at the project level to ensure their adequate site specific protection. The proposed program that is the subject of this CEQA analysis is intended to be implemented in a manner that restores and maintains the beneficial uses of the North Coast Region, including those beneficial uses identified above.

As elsewhere in the state, the quantity and quality of wetland habitat has been substantially reduced from historic levels. As such, the restoration and maintenance of the region's wetland and riparian resources is a high priority for the Regional Water Board. Riparian habitat is associated with virtually every waterbody in the North Coast Region. Substantial wetland habitat exists in the Laguna de Santa Rosa, Humboldt Bay, Bodega Bay, and associated with the estuaries of most of the rivers in the region.

Similarly, the water quality protection efforts of the Regional Water Board are intended to support and complement the environmental protection efforts represented in local policies and ordinances, Habitat Conservation Plans, Natural Community Conservation Plans, and other approved local, regional, or state habitat conservation plans.

Any project implemented under this proposed program should be designed to avoid, minimize and mitigate any potential impact to biological resources.

2.1.5 Cultural Resources

The Regional Water Board has adopted a Native American Culture (CUL) beneficial use designed to support the cultural and/or traditional practices of indigenous people such as subsistence fishing and shellfish gathering, basket weaving and jewelry material collection, navigation to traditional ceremonial locations, and ceremonial uses. The CUL beneficial use has been designated in the Smith River, Klamath River, Trinity River, Redwood Creek, Mad River, Jacoby Creek, Freshwater Creek, Salmon Creek, Van Duzen River, and Oil Creek watersheds, as well as Trinidad Hydrologic Unit, Humboldt Bay, and Ferndale Hydrologic Subarea. However, CUL is an existing beneficial use in other locations throughout the region, and which will be designated once the data are collected. The proposed program that is the subject of this CEQA analysis is intended to be implemented in a manner that restores and maintains the beneficial uses of the North Coast Region, including the CUL beneficial use.

Because the North Coast Region has a rich human history going back perhaps 10,000 years, lands throughout the region have the potential to harbor buried ancient cultural resources. Similarly, there are numerous sites of historic interest scattered throughout the region, representing the region's mining, shipping, logging, and agricultural history, among others. The presence and disposition of cultural resources must be evaluated at the project level to ensure their site-specific protection.

Any project implemented under this proposed program should be designed to avoid, minimize and mitigate any potential impact to cultural resources.

2.1.6 Geology and Soils

The California Geological Survey divides the state into 11 distinct geomorphic provinces. A geomorphic province is a naturally defined geologic region that displays a distinct landscape or landform. The Klamath River sub-basin includes the Modoc Plateau, Cascade Range, and Klamath Mountain provinces. The North Coastal sub-basin includes the Coastal Range province.

Modoc Plateau Geomorphic Province

The Modoc Plateau is a volcanic table land (elevation 4,000-6,000 feet above sea level) consisting of a thick accumulation of lava flows and tuff beds along with many small volcanic cones. Occasional lakes, marshes, and sluggishly flowing streams meander across the plateau. The plateau is cut by many north-south faults. The province is bound indefinitely by the Cascade Range on the west and the Basin and Range on the east and south.

Cascade Range Geomorphic Province

The Cascade Range, a chain of volcanic cones, extends through Washington and Oregon into California. It is dominated Mt. Shasta, a glacier-mantled volcanic cone, rising 14,162 feet above sea level.

Klamath Mountains Geomorphic Province

The Klamath Mountain Geomorphic Province has rugged topography with prominent peaks and ridges reaching 6,000-8,000 feet above sea level. In the western Klamath, an irregular drainage pattern is incised into an uplifted plateau called the Klamath peneplain. The uplift has left successive benches with gold-bearing gravels on the sides of the canyons. The Klamath River follows a circuitous course from the Cascade Range through the Klamath Mountains. The province is considered to be a northern extension of the Sierra Nevada (CDC 2002). The Klamath Mountain Geomorphic Province consists of four mountain belts: the eastern Klamath Mountain belt, central metamorphic belt, western Paleozoic and Triassic belt, and western Jurassic belt. Low-angle thrust faults occur between the belts and allow the eastern blocks to be pushed westward and upward. The central metamorphic belt consists of Paleozoic hornblende, mica schists, and ultramafic rocks. The western Paleozoic and Triassic belt, and the western Jurassic belt consist of slightly metamorphosed sedimentary and volcanic rocks. This is an uplifted and dissected peneplain on strong rocks; there are extensive monadnock ranges. Elevation ranges from 1,500 to 8,000 ft (456 to 2,432 m). Soils include Alfisols, Entisols, Inceptisols, and Ultisols, in combination with mesic and frigid soil temperature regimes and xeric and udic soil moisture regimes.

Coast Ranges
The Coast Ranges are northwest-trending mountain ranges (2,000 to 4,000, and occasionally 6,000 feet elevation above sea level), and valley. Strata dip beneath alluvium of the Great Valley. To the west is the Pacific Ocean. The coastline is uplifted, terraced and wave-cut. The Coast Ranges are composed of thick Mesozoic and Cenozoic sedimentary strata. The northern and southern ranges are separated by a depression containing the San Francisco Bay. The northern Coast Ranges are dominated by irregular, knobby, landslide-topography of the Franciscan Complex. The eastern border is characterized by strike-ridges and valley in Upper Mesozoic strata. In several areas, Franciscan rocks are overlain by volcanic cones and flows of the Quien Sabe, Sonoma and Clear Lake volcanic fields. The Coast Ranges are subparallel to the active San Andreas Fault. The San Andreas is more than 6000 miles long, extending from Point Arena to the Gulf of California (CDC 2002). This area has parallel ranges, and folded, faulted, and metamorphosed strata; there are rounded crests of subequal height. Elevations range from 1,000 to 7,500 ft (304 to 2,280 m). Soils include Alfisols, Entisols, Inceptisols, Mollisols and Ultisols in combination with mesic and thermic soil temperature regimes and xeric soil moisture regime.

Tectonics
Of prime significance to the geology and soils of the North Coast Region is the collision and subduction of the Juan de Fuca tectonic plate under the North American plate and the transform (strike-slip) movement between the Pacific and North American plates along the San Andreas fault, including activity at the Triple Junction where the North American, Gorda, and Pacific plates meet. The tectonic activity of the North Coast Region generally results in steep, unstable slopes and a mixture of consolidated and unconsolidated, marine and continental-derived geology. As a result, erosional potential in the North Coast Region can generally be described as high.

Any project implemented under this proposed program should be designed to avoid, minimize and mitigate any potential impact from erosion and sedimentation resulting from land disturbance.

2.1.7 Greenhouse Gas Emissions (GHGs)

Gases that trap heat in the atmosphere are called greenhouse gases (GHGs).[5] The major greenhouse gases of concern include the following:

- *Carbon dioxide (CO_2)*-- Carbon dioxide enters the atmosphere through burning fossil fuels (coal, natural gas and oil), solid waste, trees and wood products, and also as a result of certain chemical reactions (e.g., manufacture of cement). Carbon dioxide is removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biological carbon cycle.
- *Methane (CH_4)* -- Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.
- *Nitrous oxide (N_2O)* -- Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.
- *Fluorinated gases* -- Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for stratospheric ozone-depleting substances (e.g., chlorofluorocarbons, hydrochlorofluorocarbons, and halons). These gases are typically emitted in smaller quantities, but because they are potent greenhouse gases, they are sometimes referred to as High Global Warming Potential gases ("High GWP gases").

A statewide GHG inventory conducted by the California Air Board indicates that of the total GHG emissions in California in 2004, the categories of GHG sources rank as follows by percent contribution: transportation (38%); electricity generation (25%); industrial processes, including landfills and wastewater treatment (20%); commercial and residential fuel uses (9%); agriculture and forestry (5%); and unspecified emissions (3%). The estimate of agriculture and forestry contributions to GHG emissions includes consideration of the carbon sequestration services provided by trees and rangeland.[6]

The net GHG emissions in the state increased from 1990 to 2004 by about 12%. The source categories contributing most significantly to the increase in emissions came from electricity generation (19% increase above 1990 contributions from this source category), transportation (21% increase), agriculture and forestry (39% increase) and an increase in

[5] http://www.epa.gov/climatechange/ghgemissions/gases.html accessed August 26, 2013.
[6] http://www.arb.ca.gov/cc/inventory/archive/tables/ghg_inventory_sector_90-04_sum_2007-11-19.pdf accessed August 26, 2013.

unspecified emission sources (1161% increase). These increases were balanced by decreases in other source categories, including decreased emissions from commercial and residential fuel uses (13% decrease) and industrial fuel uses (7% decrease). The Global Warming Solutions Act of 2006 (AB 32) calls for the reduction by 2020 of GHG emissions to California's 1990 levels.

With respect to the analysis of potential environmental impacts associated with this proposed program, the source categories of most interest include: road transportation, electricity generation, landfills, wastewater treatment, residential and commercial fuel uses, and agriculture and forestry. A project implemented under this proposed program could result in an increase in GHGs over baseline conditions if it results in an increase in: fuel use associated with transportation, electricity use, land disposal or composting of waste (including wood and agricultural waste), wastewater influent volumes or concentrations, residential or commercial density. A project could result in a decrease in GHGs over baseline conditions if it results in an increase in woody biomass or a decrease in any of the categories listed above.

Any project implemented under this proposed program should be designed to avoid, minimize and mitigate any potential impact resulting from GHG emissions.

2.1.8 Hazards and Hazardous Materials

A CEQA analysis includes evaluation of the project impacts with respect to the use of hazardous substances, proximity to hazardous waste facilities, proximity to airports, likelihood of interfering with emergency response, and potential to expose people to significant wildfire risk.

Hazardous Materials

According to the California Department of Toxic Substances Control's (DTSC) website[7] there are no commercial offsite hazardous waste removal facilities in the North Coast Region, except for a used oil and antifreeze facility in the City of Fortuna. Also reported on its website, there are 12 sites in the North Coast Region included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5. They include: 1 in Del Norte, 2 in Humboldt, 1 in Lake, 3 in Mendocino, 1 in Modoc, 2 in Sonoma, 2 in Siskiyou and none in Trinity counties. Further, staff of the Regional Water Board oversees hundreds of groundwater contamination site cleanups in the North Coast Region, including leaking underground storage tank and spill sites. These sites are spread throughout the region and information about them can be found on the State Water Board's website.[8]

[7] http://www.envirostor.dtsc.ca.gov/public/ accessed August 16, 2013.
[8] http://geotracker.waterboards.ca.gov/ accessed August 16, 2013.

Risk of Wildfire
The North Coast Region is predominantly rural and largely vegetated with grassland, woodland, and forest. The California Department of Forestry and Fire Protection (CalFire) has identified hundreds of North Coast communities at risk from wildfires on either federal or non-federal lands. Further, CalFire has identified at least 5 communities as existing in a Very High Fire Hazard Severity Zone, including: Cloverdale, Santa Rosa, Ukiah, Willits, and Yreka. As such, the existing risk to North Coast residents from wildfire can be considered high.

Hazardous Substances and Emergency Response Plans
The baseline condition as it relates to the use of hazardous substance and the availability of a local emergency response plan can only be determined at the project level. A project implemented in compliance with this proposed program must conduct a project level analysis of these issues.

Any project implemented under this proposed program should be designed to avoid, minimize and mitigate any potential impact resulting from hazards and hazardous substances.

2.1.9 Hydrology and Water Quality

Water Quality
The surface water quality issues of most concern in the North Coast Region are excess sediment, elevated water temperatures, and excess nutrients. These water quality conditions are the result of point and non-point sources of pollution and other controllable factors (e.g., landscape alteration, road building, etc.) and are exacerbated by hydrologic modification, water withdrawal, and the loss of competent riparian zones and floodplains to development, agriculture, and logging. Many north coast aquatic ecosystems are impacted by these pollution sources and controllable factors, resulting in a loss of sustainable water supply, loss of aquatic habitat and risk to threatened and endangered aquatic species, increase in winter flood potential, and increase in risk of summer nuisance algal blooms (including microcystis and other cyanobacteria).

There are more localized water quality issues, as well. For example, surface water monitoring indicates a problem with pathogens in Bodega Bay Hydrologic Area, Hare Creek Beach and Pudding Creek Beach on the Mendocino Coast, several coastal beaches in the Trinidad Hydrologic Unit, and riverfront beaches on the Russian River and its tributaries, as well as the Laguna de Santa Rosa and its tributaries. In addition, several of the region's waterbodies are impaired by mercury, including: Lake Pillsbury, the Laguna de Santa Rosa, Lake Sonoma, Trinity Lake, and the East Fork Trinity River. Exotic species are listed as a water quality problem in Bodega Bay and dioxin and PCBs are listed as impairing Humboldt Bay.

In 2009, the USGS, in conjunction with the State Water Resources Control Board, collected untreated groundwater data from 58 wells selected from the California Department of Public Health (now State Water Board Division of Drinking Water) database within 34 groundwater basins located in the North Coast Region. Wells were randomly selected from Lake, Mendocino, Glenn, Humboldt, and Del Norte Counties. The results of the study are published in Methany et al. (2011). All detected concentrations of organic constituents, nutrients, major and minor ions, and radioactive constituents were less than health-based benchmarks for the 30 wells sampled in the Northern Coast Ranges. There were a few detections of arsenic, boron, and barium in the 28 wells of the interior basins that exceeded drinking water standard maximum contaminant levels (MCLs) or notification levels; but, these are likely related to the area's geology. The results of this study indicate that community drinking water systems drawing from primary aquifer systems in the North Coast Region generally provide safe drinking water, with the exceptions noted.

Groundwater quality problems in the North Coast Region include contamination from seawater intrusion and nitrates in shallow coastal groundwater aquifers; high total dissolved solids and alkalinity in groundwater associated with the lake sediments of the Modoc Plateau basins; and iron, boron, and manganese in the inland groundwater basins of Mendocino, Sonoma, and Siskiyou counties. Past and potential septic tank failures in western Sonoma County at Monte Rio and Camp Meeker, along the Trinity below Lewiston Dam, in the vicinity of Fort Bragg along the Mendocino Coast, and the shore of Arcata in Humboldt Bay, and various other areas throughout the region, are a concern due to potential impacts to groundwater wells and recreational water quality. Potential contributions of nutrients and pesticides to shallow groundwater are resulting from the continued conversion of land to vineyards in Sonoma and Mendocino counties, widespread farming activities in the Upper Klamath River basin and the Smith River plain and other agricultural activities at locations throughout the region. Aging wastewater treatment ponds and leaking septic tanks play a part in shallow groundwater contamination in the region, as well. Groundwater is likely to become an increasingly important source of domestic, municipal, and agricultural water supply, as a result of climate change and predicted effects on surface water discharge volumes and timing. However, a significant amount of shallow groundwater has been contaminated by a long history of activities and operations, primarily: wood treatment facilities, unlined landfills, leaking underground storage tanks, dry cleaning facilities, inadequate wastewater treatment ponds, and insufficient septic systems. In many basins, shallow groundwater is neither used nor useable. But, because the North Coast Region is predominantly rural, many people rely on shallow (sometimes hand-dug) wells for their drinking water.

In the 2014 California Water Plan, the Department of Water Resources (DWR) presents information gathered on groundwater use in the North Coast Region[9]. As noted there is

[9] http://www.waterplan.water.ca.gov/

limited large-scale groundwater development in the North Coast Region due to the small number of significant coastal aquifers. Most of the groundwater development that has occurred comes from shallow wells installed adjacent to rivers. There are, however, significant groundwater basins underlying the Klamath River Valley (including Tule Lake, and Lower Klamath Sub-basins), Santa Rosa Valley, Shasta Valley, Smith River Plain, Ukiah Valley, Eel River Valley, Scott River Valley and Butte Valley. Despite the limits on large-scale infrastructure, groundwater is used widely throughout the region for individual domestic, agricultural, and industrial water supply. Many rural areas rely exclusively on private wells for residential water. According to a review of driller well logs from 1977 to 2010 approximately 35,000 wells were installed in the North Coast Region. Of those approximately 70% are for domestic use, 17% for environmental monitoring, 5% for agricultural irrigation, 2% for public water supply and less that 1% for industrial supply. While domestic wells are more numerous than agricultural wells, approximately 83% of the groundwater used between 2002 and 2010 was for agricultural purposes while 15% was for urban/domestic use. (DWR 2013)

Hydrology
Because of the low infiltration capacity and permeability of the Franciscan and volcanic rocks common in the North Coast Region, groundwater origin baseflows in streams are sometimes poorly maintained. Along the mountain drainages, baseflow that does occur is maintained by groundwater discharge emerging from fractures through springs and seeps. Some streams may be composed of discontinuous wet reaches with pools sustained over summer by groundwater discharge. Some higher elevation streams may run dry from summer to late fall. As a consequence, flows between these ephemeral streams and the underlying aquifer may periodically cease.

In the valleys, groundwater occurs in the alluvial deposits. Many rural residents throughout the region intercept groundwater in fractures or localized alluvium. In these settings, groundwater may be impacted by periodic or seasonal depletion. There, baseflow is maintained by groundwater discharge along reaches where the water table is higher than the adjacent stream. In the larger valley drainages, such as the Russian River, groundwater discharge is large enough to sustain perennial flow (R2 Resource Consultants & Stetson Engineers, 2007). This is similarly the case in the Klamath River basin. Though, studies in the Scott River Valley and the Santa Rosa Plain indicate that groundwater pumping for irrigation has impacted stream flow in the Scott River and Laguna de Santa Rosa watersheds, respectively.

With respect to groundwater depletion, the potential is a noted risk within groundwater basins in the Santa Rosa Plain, the lower Mad River area, the town of Mendocino, Scott

Valley, and Tule Lake and has resulted in the investment of numerous stakeholders developing voluntary groundwater management plans.

The *Sustainable Groundwater Management Act* (SGMA) was signed by Governor Edmund G. Brown Jr. on September 16, 2014, and includes the provisions of Senate Bill (SB) 1168, Assembly Bill (AB) 1739, and SB 1319. A central feature of the SGMA is the recognition that groundwater management in California is best accomplished locally. The SGMA builds upon the existing groundwater management provisions established by AB 3030 (1992), SB 1938 (2002), and AB 359 (2011), as well as SBX7 6 (2009) which established the California Statewide Groundwater Elevation Monitoring (CASGEM) Program.

The SGMA requires the formation of locally-controlled Groundwater Sustainability Agencies (GSAs) which must develop Groundwater Sustainability Plans (GSPs) in groundwater basins or subbasins that DWR designates as medium or high priority. The legislative intent of the SGMA is to achieve all of the following:

- To provide for the sustainable management of groundwater basins.
- To enhance local management of groundwater consistent with 1) rights to use or store groundwater and 2) Section 2 of Article X of the California Constitution.
- To establish minimum standards for sustainable groundwater management.
- To provide local groundwater agencies with the authority and the technical and financial assistance necessary to sustainably manage groundwater.
- To avoid and minimize subsidence.
- To improve data collection and understanding about groundwater.
- To increase groundwater storage and remove impediments to recharge.
- To manage groundwater basins through the actions of local governmental agencies to the greatest extent feasible, while minimizing state intervention.

The SGMA defines sustainable groundwater management as "the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results." Undesirable results are defined as any of the following effects:

- Chronic lowering of groundwater levels (not including overdraft during a drought if a basin is otherwise managed).
- Significant and unreasonable reduction of groundwater storage.
- Significant and unreasonable seawater intrusion.
- Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.
- Significant and unreasonable land subsidence that substantially interferes with surface land uses.
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

There are currently eight medium priority basins within the North Coast including:

1. Smith River Plain
2. Eel River Valley
3. Scott River Valley
4. Shasta River Valley
5. Tule Lake
6. Ukiah Valley
7. Santa Rosa Plain
8. Butte Valley

Surface flows in the North Coast Region are impacted by numerous water diversions, both permitted and unpermitted, legal and illegal. The State Water Board has adopted the North Coast Instream Flow Policy to better ensure that future water rights permits contain the provisions necessary to protect the stream flows necessary to support salmonids and salmonid habitat. Further, recent collaboration between the staff of the North Coast Region and the Division of Water Rights has resulted in contemporary water rights permits containing provisions specific to the protection of water quality conditions in the North Coast Region. For example, erosion control plans and riparian protection plans are sometimes required in new water rights permits.

On the other end of the spectrum, the North Coast Region contains hundreds of miles of rural private and public roads which sometimes serve to extend the drainage network of the region's watersheds with inadequate, poorly designed, or failing road drainage features. The result, in some watersheds, has been an increase in peak flows or change in peak flow timing, accompanied by an increased risk of erosion, sedimentation, and flooding.

Also with respect to flooding, many of the watersheds of the North Coast Region are still moving quantities of stored sediment first deposited during catastrophic flooding events of 1955 and 1964. Flooding events of 1982, 1995, and 1997 also have had dramatic impact on North Coast rivers. The California Emergency Management Agency has mapped a tsunami inundation risk for all of Del Norte County, Humboldt County from its border with Del Norte to Ferndale, Mendocino County from Brunel Point to Gualala, and Sonoma County from Russian Gulch to Bodega Head.[10]

Recycled Water

"Recycled water" means water that, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur and is therefore considered a valuable resource[11]. California experiences frequent drought conditions. On April 25, 2014, the Governor proclaimed a continued State of Emergency due to severe drought conditions and directed the State Water Board to adopt statewide general waste

[10] http://www.consrv.ca.gov/cgs/geologic_hazards/Tsunami/Inundation_Maps/Pages/Statewide_Maps.aspx accessed August 16, 2013.
[11] CWC § 13050(n).)

discharge requirements to facilitate the use of treated wastewater that meets standards set by the former California Department of Public Health (CDPH) Division of Drinking Water, now the State Water Board Division of Drinking Water (DDW) in order to reduce demand on potable water supplies. Recent emergency actions follow a similar Declaration of Statewide Drought in effect from 2008 through 2011 (Executive Order S-06-08) and Drought Declaration State of Emergency in effect from 2009 through 2011 (Executive Order S-11-09). Drought conditions in California also persisted from 1987 through 1992. Paleoclimatologists have reconstructed medieval climate episodes from tree ring studies, sediment deposition, and other sources. These studies show that the most severe droughts during the past 1,000 years have lasted from 20 to more than 150 years.

Recycled water use can help to reduce local water scarcity. It is not the only option for bringing supply and demand into a better balance; but, it is a viable cost effective solution that is appropriate in many cases. The feasibility of recycled water use depends on local circumstances, which affect the balance of costs and benefits. In drought conditions, recycled water can be particularly valuable, given the scarcity of alternative supplies. In normal precipitation years recycled water use may reduce groundwater extraction, which could also be augmented with storm water capture and infiltration and groundwater recharge. For additional discussion on groundwater management see Section 2.2 existing regulatory framework.

Any project implemented under this proposed program should be designed to avoid, minimize and mitigate any potential impact resulting from controllable factors with the potential to impact hydrology or water quality.

2.1.10 Land Use and Planning

As above, it is not the intention of this proposed program to interfere with or supersede any land use plan, policy or regulation of another agency. A project-level analysis is necessary to ensure that the project is designed and/or mitigated in such a manner as to comply with the requirements of other agencies.

2.1.11 Mineral Resources

Like elsewhere in the state, the North Coast Region was substantially impacted by the California gold rush of 1949, particularly in the Klamath Geomorphic Province where hundreds of gold claims were exercised and where suction dredging is still of interest. Abandoned mines in the Klamath Basin are the focus of cleanup. Further, sand, gravel and other aggregate is a substantial commodity of the North Coast Region, impacting numerous watersheds in the region. A project-level analysis is necessary to ensure that the project is designed and/or mitigated in such a manner as to consider it within the context of cumulative water quality impacts which may arise in conjunction with historical and contemporary mineral extraction.

2.1.12 Noise

The North Coast Region is substantially rural, with a limited number of larger communities, the largest being Santa Rosa and its surrounding communities in Sonoma County. As a general matter, noise pollution is limited to localized areas. As above, any project implemented as a result of this proposed program must be evaluated on a site-specific basis, appropriately avoiding, minimizing, and mitigating potential impacts.

2.1.13 Population, Housing, and Public Services

The North Coast Region includes all residents of Del Norte, Humboldt, Trinity, and Mendocino counties, the majority of Modoc, Siskiyou, and Sonoma counties, and a small percentage of the populations of Glenn, Lake and Marin counties. The population of the entire North Coast Region was about 670,700 in year 2010[12], which is less than 2 percent of California's total population. More than half of this region's population lives in the southern part, primarily in Santa Rosa and the surrounding communities of Cotati, Healdsburg, Rohnert Park, Sebastopol and Windsor in the Russian River Watershed with a population of 261,485 people in year 2010[13], which is heavily influenced by the overall urban expansion of the adjacent San Francisco Bay region. Other smaller communities in the northern portions of this region include Eureka, 27,191; Ukiah, 16,075; Arcata, 17,231; Crescent City, 7,643; and Yreka, 7,765.[14]

When compared with the 2000 regional population of 636,000, the 670,300 in 2010 represents a growth rate of 5.4 percent over the 10 years, which is a little over half the statewide growth rate of about 9.7 percent over the same period. Projections today indicate that the regional population is expected to grow to about 809,400 by year 2050, which represents approximately 21 percent increase from year 2010 totals. More than half of this projected growth is anticipated to occur in the Santa Rosa region, as urban populations from the San Francisco Bay area continue to expand north. Population increases in the rural communities in the northern portion of this region are projected to grow more slowly.

The North Coast Region has experienced steady population growth over the past two decades and is projected to continue positive growth through the year 2050[15]. Due to the rural nature of much of the region and the fact that there is a lower associated cost of living, many communities within the region are seeing an influx of retirees from larger, more urbanized settings. This has placed pressure on existing community services. Additionally, as population densities encroach in the more urban settings, some of the more rural communities are becoming bedroom communities. There is also a rise in migrant workers

[12] http://www.dof.ca.gov/research/demographic/state_census_data_center/census_2010/ accessed August 16, 2013.
[13] Ibid.
[14] Ibid
[15] Ibid.

within the region. Modoc County has a county-operated migrant camp. The trend for both Modoc and Siskiyou counties is that many of the migrant workers are becoming permanent residents, while younger non-migrant residents continue to leave the area. Despite the overall growth rates of the region, population growth rates are not as great as those of the rest of the Sstate, reflecting the rural character of the region. In fact, some of the more remote counties of the region - Modoc and Siskiyou - are projected to lose overall population in the coming decades.

Any project implemented under this proposed program should be designed to avoid, minimize and mitigate any potential impacts.

2.1.14 Recreation

The Regional Water Board implements water quality protection programs designed to result in water quality suitable for full contact water recreation such as swimming and surfing (REC-1), as well as non-contact water recreation (REC-2). Other beneficial uses potentially relevant to the topic of recreation include Navigation (NAV), Commercial and Sport Fishing (COMM), and Shell Fish Harvesting (SHELL). As a predominantly rural region, the North Coast Region offers a multitude of recreational opportunities in addition to water-related activities, including camping, hiking, backpacking, horseback riding, bike riding, bird watching, and much more. Protection of REC-1 and REC-2 uses must be incorporated into any specific project implemented under this proposed program.

2.1.15 Transportation/Traffic, Utilities and Service Systems

Transportation and Traffic

The North Coast Region is serviced by Districts 1, 2, and 4 of the California Department of Transportation (Caltrans). Highway 101 is the major highway corridor from north to south and Highways 128, 20, 162, 36, 299, and 199 are the major highway corridors from west to east. These highway corridors are 2 and 4 lane highways, vulnerable to traffic delays when road work is undertaken. Caltrans projects currently affecting transportation and traffic include: the Willits Bypass in District 1; on-going maintenance on Hwy 299 and the Anderson Grade Project near Yreka in District 2; and road widening on Hwy 101 through Sonoma County in District 4. Activities associated with the development of the Sonoma-Marin Area Rail Transit (SMART) from Cloverdale in Sonoma County to the Larkspur Landing ferry terminal in Marin County also have the potential to cause traffic congestion as a baseline condition.

Airports

There are numerous airports throughout the North Coast Region, including 3 passenger airports: the Jack McNamara Field Airport in Del Norte County, the Arcata-Eureka Airport in Humboldt County, and the Charles Schultz Airport in Sonoma County. In addition, there are 22 public use airports found in Cloverdale, Covelo, Eureka (3), Fortuna, Garberville, Gasquet, Gualala, Hayfork, Healdsburg, Hoopa, Hyampom, Klamath Glen, Little River, Sonoma, Trinity Center, Tulelake, Ukiah, Weaverville, and Willits.

Wastewater Treatment Facilities, Water Treatment Facilities, Stormwater Facilities, Landfills
The point source discharge of waste to waters of the region is prohibited except in the Mad, Eel, and Russian rivers during the wet weather season. All other wastewater treatment is provided by percolation ponds, evaporation ponds, or other land disposal, including septic systems. Discharge to the Mad, Eel and Russian rivers is further limited to 1% of river flow. Many of the wastewater treatment systems, including septic systems, in the North Coast Region are very old and require upgrade.

Water is abundant in many parts of the North Coast Region. According to Methany et al. (2011), a sampling of community water delivery systems in the North Coast Region provides good drinking water to their customers. Many residents of the North Coast Region, however, rely on private domestic wells, surface water intakes, or small community systems; except in localized areas, water availability is generally good and is sometimes consumed untreated. The Regional Water Board implements water quality protection programs designed to result in water resources that are suitable as drinking water. Protection of drinking water, as defined by the Municipal and Domestic Supply (MUN) beneficial use, is fundamental to this draft proposed program.

The Regional Water Board implements several National Pollutant Discharge Elimination System (NPDES) permits for the control of storm water from industrial facilities, construction sites, and municipalities. These primarily rely on best management practices (BMPs) to avoid, minimize and mitigate the impacts of storm water discharge. Large and small municipal sewer system operators must comply with permits that regulate storm water entering their systems under either a Phase I or a Phase II permit. . Phase I permit regulates storm water discharges from medium (serving between 100,000 and 250,000 people) and large (serving 250,000 people) municipalities. Phase II permit regulates smaller (serving less than 100,000 people) municipalities, including non-traditional small operations, such as military bases, public campuses, and prison and hospital complexes. The largest, single municipal discharger in California is the California Department of Transportation (Caltrans) and its network of highways and road facilities operate under an individual municipal separate storm sewer system (MS4) permit. The City of Santa Rosa, Sonoma County, and Sonoma County Water Agency implement an extensive storm water control program under the only Phase I MS4 permit issued by the Regional Water Board. Phase II dischargers within the region include:

<u>Traditional Phase IIs</u>

- Arcata
- Eureka
- Fortuna
- McKinleyville
- Trinidad
- Crescent City
- Bayview CDP
- Cutten CDP
- Humboldt Hill CDP
- Myrtletown CDP
- Pine Hills CDP
- Ridgewood Heights
- Rosewood USSA
- Cloverdale CDP
- Forestville CDP
- Guerneville CDP

- Cotati
- Healdsburg
- Rohnert Park
- Windsor
- Sebastopol
- Monte Rio
- Occidental
- Yreka
- Fort Bragg
- Mendocino County
- Ukiah

<u>Non-Traditional Phase IIs</u>

- Sonoma State University
- Humboldt State University
- Caspar Headlands SB
- Caspar Headlands State Reserve
- Del Norte Coast Redwoods State Park
- Humboldt Lagoons State Park
- Jug Handle State Reserve
- Mendocino Headlands State Park
- Mill Creek Property
- Patrick's Point State Park
- Pelican Bay State Beach
- Point Cabrillo Light Station Property
- Prairie Creek Redwoods State Park
- Sinkyone Wilderness State Park
- Tolowa Dunes State Park
- Trinidad State Beach
- Petaluma Coast Guard Training Center

All the landfills in the North Coast Region have been closed, except the Central Disposal site off Meecham Road in Sonoma County. Transfer Stations are operated throughout the rest of the region with much of the waste material transferred outside the Region for disposal. Additional description of the land disposal program is provided in Section 2.2.1

Any project implemented under this proposed program should be designed to avoid, minimize and mitigate any potential impacts resulting from transportation, wastewater treatment and discharge, stormwater capture and discharge, and landfill design and management.

2.2 Existing Regulatory Framework

The Regional Water Board administers both state and federal regulations for water quality control. Discharges to surface waters are regulated via orders pursuant to section 402 of the federal Clean Water Act (CWA) and regulations adopted by the USEPA, as well as chapter 5.5, division 7 of the California Water Code (commencing with section 13370). Such an order serves as an NPDES permit for point source discharges to surface waters.

Discharges to waters of the state (groundwaters and surface waters) are regulated by orders which serve as Waste Discharge Requirements (WDRs) or waivers thereof pursuant the California Water Code (commencing with section 13260).

State Water Board describes the planning authority under Porter-Cologne to extend to any activity or factor that may affect water quality, including waste discharges, saline intrusion, reduction of waste assimilative capacity caused by reduction in water quantity, hydrogeologic modifications, watershed management projects, and land use. It further makes clear that all dischargers are subject to regulation under the Porter-Cologne Act including both point and nonpoint source dischargers (SWRCB 2004).

Water quality objectives in the Basin Plan are developed to protect all applicable beneficial uses, including the MUN beneficial use unless otherwise stated. The Basin Plan includes a number of water quality objectives that address drinking water, human health and aquatic ecosystem protection. There are narrative objectives for chemical constituents, taste and odor, sediment, suspended material, temperature, and toxicity, and numeric objectives for chemical constituents and salinity, among others. The Basin Plan has incorporated the maximum contaminant levels (MCLs) specified in Title 22 of the California Code of Regulations in 1975 for waters designated MUN. While the numeric values specified in Title 22 have since been updated, the values in the Basin Plan have not. Additionally, the Regional Water Board deals with a large number of potential constituents of concern (i.e., contaminants) that do not have drinking water standards (i.e., MCLs). The lack of an MCL does not mean that the chemical does not pose a threat to human health or aquatic life. Therefore, based on the statewide policies and authorities given to the Regional Water Board to protect beneficial uses, more relevant values (toxicity information) have been applied in regulatory actions and orders to protect those beneficial uses.

There are a number of existing State Water Board policies that, in addition to Basin Plan requirements, are implemented for the protection of human health and aquatic life. The following contains a list of the policies and brief summaries.

State Water Board Resolution No. 68-16, Policy with Respect to Maintaining High Quality of Water in California

Commonly known as the State's Antidegradation Policy, the goal of this policy is to maintain high quality waters. Whenever the existing water quality is better than the established water quality objectives, such existing quality shall be maintained. Changes in water quality are allowed only if the change is consistent with maximum benefit to the people of the State; does not unreasonably affect present and anticipated beneficial uses; and does not result in water quality less than that prescribed in water quality control plans or policies. The application of the Antidegradation Policy protects existing and future beneficial uses of water and requires the best practicable treatment technologies. Resolution No. 68-16 also incorporates the federal antidegradation policy which applies to all federal surface waters. The Antidegradation Policy is generally applied at the time an individual action is contemplated within the context of a WDR or other action of the Regional Water Board.

State Water Board Resolution No. 88-63, Sources of Drinking Water Policy
Commonly known as the Sources of Drinking Water Policy, establishes the state policy that all waters are considered suitable or potentially suitable to support the MUN beneficial use, with certain exceptions. The Basin Plan implements State Water Board Resolution 88-63 ("Sources of Drinking Water Policy") by assigning MUN to all surface water bodies listed in Table 2-1 of the Basin Plan, except ocean waters, bays, and saline wetlands. Pursuant to Resolution No. 88-63, the following exceptions to the MUN designation are allowed for surface waters and groundwaters:

1) With total dissolved solids exceeding 3,000 mg/L,
2) With contamination that cannot reasonably be treated for domestic use,
3) Where there is insufficient water supply for a single well to provide an average, sustained yield of 200 gallons per day,
4) In systems designed for wastewater collection or conveying or holding agricultural drainage, or
5) Regulated as a geothermal energy producing source.

Resolution 88-63 addresses only designation of water as drinking water sources; it does not establish objectives for constituents that are protective of the designated MUN use.

Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California
Commonly known as the State Implementation Policy (SIP), the State Water Board adopted this policy as Resolution No. 2000-015 in March 2000. The National Toxics Rule (NTR) and California Toxics Rule (CTR) include criteria to protect human health, as promulgated by USEPA. The SIP is implemented primarily through the National Pollutant Discharge Elimination System (NPDES) permitting program. It establishes a standardized approach for permitting wastewater discharges of toxic pollutants. This Policy establishes:

- Implementation provisions for priority pollutant criteria promulgated by the USEPA through the NTR (40 CFR 131.36) (promulgated on 22 December 1992 and amended on 4 May 1995) and through the CTR (40 CFR 131.38) (promulgated on 18 May 2000 and amended on 13 February 2001), and for priority pollutant objectives established by Regional Water Boards in their basin plans;
- Monitoring requirements for 2,3,7,8-TCDD equivalents; and
- Chronic toxicity control provisions.

Policies and Procedures for Investigation and Cleanup and Abatement of Discharges Under Water Code Section 13304, State Water Board Resolution No. 92-49
This policy contains procedures for the Regional Water Board to follow for oversight of cleanup projects to ensure cleanup and abatement activities protect the high quality of surface water and groundwater. This policy requires the cleanup and abatement of

constituents of concern to levels that would not pose a risk to water quality, human health or the environment. Cleanup and abatement activities are to be performed in a manner that either achieves background water quality, or the best water quality which is reasonable taking all demands being made and to be made on those waters and the total values involved. Generally, cleanup goals are established at natural background levels for constituents with natural sources and zero (or non-detect) for all other constituents. Cleanup criteria are derived from human health-based criteria, including toxicity criteria, when zero, non-detect, or natural background is not reasonably achievable. Or, they are derived from aquatic life criteria, where groundwater is connected to surface water and aquatic organisms are the most sensitive receptors. This policy establishes the procedures for identifying containment zones and determining the economic feasibility of assessment and remedial actions. Additionally, the policy requires mitigation actions to reduce significant adverse impacts to water quality, human health and the environment, including any nuisance conditions[16] such as impacts to taste and odor that affect a whole community or neighborhood. The basis for Regional Water Board decisions regarding investigation, and cleanup and abatement includes:

1) Site–specific characteristics;
2) Applicable state and federal statutes and regulations;
3) Applicable water quality control plans adopted by the State Water Board and Regional Water Boards, including beneficial uses, water quality objectives, and implementation plans;
4) State Water Board and Regional Water Board policies, including State Water Board Resolutions No. 68-16 (Antidegradation) and No. 88-63 (Sources of Drinking Water). This reiterates the requirement for cleanup and abatement actions to achieve background conditions; and
5) Relevant standards, criteria, and advisories adopted by other state and federal agencies.

The policy explicitly states, "No provision of this Policy shall be interpreted to allow exposure levels of constituents of concern that could have a significant adverse effect on human health or the environment."

Policy for Water Quality Control for Recycled Water, State Water Board Resolution 2009-0011, (Recycled Water Policy, Revised January 22, 2013, effective April 25, 2013.) The Recycled Water Policy promotes the use of recycled water to achieve sustainable local water supplies and reduce greenhouse gas emissions. Water recycling is an essential part of an overall program to manage local and regional water resources. Many local governing bodies have adopted resolutions establishing their intent to proceed with planning, permitting, and implementation of recycled water projects. These projects will provide

[16] Nuisance as defined in Porter-Cologne §13050

water supply and municipal wastewater disposal benefits for communities, and will provide water supply benefits to agriculture.

Several municipalities and smaller industrial and commercial dischargers in the North Coast have implemented recycled water project including but not limited to:

- City of Santa Rosa (including areas of Rohnert Park and Cotati);
- Town of Windsor;
- Graton Community Service District;
- City of Healdsburg;
- Crescent City;
- City of Willits; and
- Sonoma County Water Agency

The Recycled Water Policy recognizes the fact that some groundwater basins in the state contain salts and nutrients that exceed or threaten to exceed water quality objectives in the applicable Basin Plans or cause degradation of high quality waters, and that not all Basin Plans include adequate implementation procedures for achieving or ensuring compliance with the water quality objectives and the Antidegradation Policy for salt or nutrients. The Recycled Water Policy finds that the appropriate way to address salt and nutrient issues is through the development of regional or subregional Salt and Nutrient Management Plans (SNMPs) rather than through imposing requirements solely on individual recycled water projects.

This Recycled Water Policy describes permitting criteria that are intended to streamline the permitting of the vast majority of recycled water projects. The intent of this streamlined permit process is to expedite the implementation of recycled water projects in a manner that implements state and federal water quality laws while allowing the Regional Water Boards to focus their limited resources on projects that require substantial regulatory review due to unique site-specific conditions.

The State Water Board acknowledges that all projects that involve recycled water recharge to groundwater must be reviewed and permitted on a site-specific basis. Activities involving the disposal of waste that could impact high quality waters are required to implement best practicable treatment or control of the discharge necessary to ensure that pollution or nuisance will not occur, and the highest water quality consistent with the maximum benefit to the people of the state will be maintained, as per the Antidegradation Policy. These findings are made by the Regional Water Board after public review and hearing

Water Quality Control Policy for Low-Threat Underground Storage Tanks Case Closure, State Water Board Resolution No. 2012-0016 (Low-Threat UST Closure Policy).
The State Water Board believes it is in the best interest of the people of the state that unauthorized releases be prevented and cleaned up to the extent practicable in a manner

that protects human health, safety and the environment. The State Water Board also recognizes that the technical and economic resources available for environmental restoration are limited, and that the highest priority for these resources must be the protection of human health and environmental receptors. Program experience has demonstrated the ability of remedial technologies to mitigate a substantial fraction of a petroleum contaminant mass with the investment of a reasonable level of effort. Experience has also shown that residual contaminant mass usually remains after the investment of reasonable effort, and that this mass is difficult to completely remove regardless of the level of additional effort and resources invested.

As noted above, State Water Board Resolution 92-49, is a state policy for water quality control and applies to petroleum UST releases, in addition to other wastes. State Water Board Resolution 92-49 directs that water affected by an unauthorized release attain either background water quality or the best water quality that is reasonable if background water quality cannot be restored. Any alternative level of water quality less stringent than background must be consistent with the maximum benefit to the people of the state, not unreasonably affect current and anticipated beneficial use of affected water, and not result in water quality less than that prescribed in the water quality control plan for the basin within which the site is located. Resolution No. 92-49 does not require that the requisite level of water quality be met at the time of case closure; it specifies compliance with cleanup goals and objectives within a reasonable time frame.

The Low-Threat Closure Policy has general criteria that must be satisfied by all candidate sites are listed as follows:

a. The unauthorized release is located within the service area of a public water system;
b. The unauthorized release consists only of petroleum;
c. The unauthorized ("primary") release from the UST system has been stopped;
d. Free product has been removed to the maximum extent practicable;
e. A conceptual site model that assesses the nature, extent, and mobility of the release has been developed;
f. Secondary source has been removed to the extent practicable;
g. Soil or groundwater has been tested for methyl tert-butyl ether (MTBE) and results reported in accordance with Health and Safety Code section 25296.15; and
h. Nuisance as defined by Water Code section 13050 does not exist at the site.

Water Quality Control Policy for Siting, Design, Operation, and Maintenance of Onsite Wastewater Treatment Systems, State Water Resources Control Board Resolution No. 2012-0032 (OWTS Policy)

The purpose of the OWTS Policy is to allow the continued use of OWTS, while protecting water quality and public health. To accomplish this purpose, the OWTS Policy establishes a statewide, risk-based, tiered approach for the regulation and management of OWTS installations and replacements and sets the level of performance and protection expected from OWTS. The OWTS Policy only authorizes subsurface disposal of domestic strength, and in limited instances high strength, wastewater and establishes minimum requirements for the permitting, monitoring, and operation of OWTS for protecting beneficial uses of waters of the state and preventing or correcting conditions of pollution and nuisance.

The OWTS Policy implements criteria for siting, design, operation implements levels (tiers) of requirements based upon potential threat to water quality that may be caused by the OWTS. The tiers are as follows:

Tier 0 provides a conditional waiver of waste discharge requirements for existing, properly functioning systems that are not failing or in need of corrective action (Tier 4) and are not determined to be contributing to an impairment of surface water (Tier 3). Tier 0 conditions for existing OWTS are specified in section 6 of the OWTS Policy.

Tier 1 provides a conditional waiver of waste discharge requirements for new or replacement systems that comply with specific criteria intended to be protective of water quality. The criteria are intentionally conservative (similar to those previously adopted by the Regional Water Board) to ensure that use of such systems, without specific monitoring, will not result in water quality impairment. Tier 1 conditions for low-risk OWTS are specified in sections 7 and 8 of the OWTS Policy.

Tier 2 provides alternative criteria to be implemented by local governing jurisdictions in areas with approved Local Agency Management Plans (LAMPs). At its discretion, the local agency may implement a LAMP that provides a similar level of water quality protection while addressing unique geologic conditions or management approaches. Where LAMPs have been approved by a regional board, the LAMP requirements supersede Tier 1 criteria. Tier 2 requirements for LAMPs are described in section 9 of the OWTS Policy.

Tier 3 provides special conditions for OWTS located near impaired waters listed in Attachment 2 of the OWTS Policy. New, existing, and replacement OWTS must comply with the applicable Total Maximum Daily Load (TMDL) implementation program, or special provisions contained in a LAMP. Where there is no TMDL or special provisions in place, new or replacement OWTS within 600 feet of certain impaired waters listed in Attachment 2 of the OWTS Policy must meet advanced protection requirements specified in the policy. The Tier 3 advanced treatment requirements are in section 10 of the OWTS Policy.

Tier 4 specifies corrective actions for failing OWTS. After completion of corrective action and repair, the onsite system would then return to Tier 1, Tier 2, or Tier 3 (whichever is appropriate in the specific circumstances). Tier 4 criteria for OWTS requiring corrective action are specified in section 11 of the OWTS Policy.

In accordance with Section 4.2.1 of the OWTS Policy, the Regional Water Board will continue to implement its existing Basin Plan requirements pertaining to onsite systems within the Russian River watershed until it adopts the Russian River TMDL, at which time it will comply with section 4.2 of the OWTS Policy for the Russian River watershed. The Russian River watershed includes the Laguna de Santa Rosa.

The policies described above establish the most significant of the regulatory authorities implemented by the Regional Water Board with respect to the protection of water quality from discharges of chemical constituents, including toxic constituents.

2.2.1 Existing Program of Implementation for Chemical Constituents and Groundwater Toxicity

Water quality-based effluent limitations are established in Regional Water Board permits, orders, and other regulatory actions primarily to ensure that the water quality is attained or maintained at a level that protects aquatic life, human health, and other beneficial uses from adverse impacts. When developing effluent limitations and other numeric limits in permits, orders, and other regulatory actions, staff currently implements the Basin Plan and all of the policies and plans described above, as appropriate. In general, the methods that staff uses to determine the most appropriate discharge limitation or cleanup level include:

1) Characterize the waste and characteristics of the site;
2) Identify the discharge point and any of the surrounding area that may be threatened by discharge of waste;
3) Identify the beneficial uses of the waterbody in question from which to determine the most sensitive potential receptors for which discharge limitations/cleanup levels must be designed;
4) Identify the relevant existing narrative and/or numeric water quality objectives within the Basin Plan;
5) Apply other relevant policies and procedures (e.g., SIP, Resolution No. 92-49, Resolution No. 68-16); and
6) Apply (a) the relevant numeric Basin Plan objectives; (b) the most appropriate numeric criteria derived from the translation of relevant narrative Basin Plan objectives; and (c) the most appropriate numeric criteria derived from other relevant State or Federal laws, regulations, plans or policies, whichever provides the best and most appropriate protection of the most sensitive beneficial uses.

For a better understanding of the existing regulatory framework, each of the significant water quality protection programs implemented by the Regional Water Board are described in more detail below.

Wastewater

NPDES program is a federal program, which has been delegated to the State of California for implementation. Wastewater NPDES permits are issued to regulate the discharge of municipal wastewater or industrial process, cleaning, or cooling wastewaters; commercial wastewater; treated groundwater from cleanup projects; or other wastes discharged to surface waters, including federal jurisdictional wetlands. NPDES permits may also serve as WDRs that implement additional provisions of state law. General NPDES permits are issued under the Site Cleanup Program to regulate the year-round discharge to surface waters of highly treated groundwater extracted from cleanup projects involving volatile organic compounds.

All municipalities within the North Coast Region that discharge wastewater to surface waters are currently regulated by NPDES permits issued by the Regional Water Board. Industrial, commercial, cleanup or other operations that discharge wastes directly into municipal, or other publicly owned wastewater collection systems are not required to obtain an NPDES permit from the Regional Water Board, but must comply with waste discharge requirements issued by the appropriate public entity.

For NPDES permits, the implementation procedures described in the SIP (and summarized in Section 2.2 above) apply, in conjunction with the Basin Plan water quality objectives for developing effluent limits. Section three of the Basin Plan states "Whenever several different objectives exist for the same water quality parameter, the strictest objective applies. Additionally, the SIP states "If a water quality objective and a CTR criterion are in effect for the same priority pollutant, the more stringent of the two applies." Staff has used the process contained in the SIP for setting effluent limits for wastewater NPDES permits since it was adopted in 2000.

WDRs are the state permitting authority that is used in conjunction with an NDPES permit or alone when there is no discharge to federal waters. WDRs regulating discharges of waste to land generally follow the process for establishing effluent limits as described in the State Administrative Procedures Manual (APM). For WDRs, such levels are determined on a case-by-case basis considering the nature of the contaminants, the type of soil, the depth to groundwater, distance to surface water, and other hydrogeologic characteristics. Non-municipal waste discharges typically regulated by NPDES and/or WDR permits may include:

- Canneries
- Dairies
- Mines
- Mobile home parks
- Fish hatcheries
- Wineries and other food processing plants
- Groundwater cleanup projects
- Hardboard manufacturing plants
- Pulp mills
- Sawmills

The Non-Chapter 15 Permitting, Surveillance and Enforcement Program is a State mandated program under which WDRs are issued to regulate the discharge of municipal, industrial, commercial and other wastes to land only. If the waste discharge consists only of non-process storm water, it may be regulated under the NPDES storm water program. The discharge of waste to surface water (rivers, streams, lakes, wetlands, drains, and the Pacific Ocean) is regulated under the NPDES program.

All municipalities within the North Coast Region that discharge wastewaters or waste solids to land are currently regulated by WDRs issued by the Regional Water Board or the State Water Board (e.g. General WDRs for Recycled Water, OTWS and biosolids). Industrial, commercial, or other operations that discharge to municipal or other publicly owned wastewater collection systems are not required to obtain WDRs under this program, but must comply with local requirements or pre-treatment requirements issued by the appropriate public entity. Non-municipal waste discharges typically regulated by WDRs under the Non-Chapter 15 Permitting, Surveillance and Enforcement program within the North Coast Region include: dairies, mines, mobile home parks, sawmills, and wineries.

Storm Water
In addition to NPDES wastewater permits, there are four statewide NPDES storm water permits issued by the State Water Board and implemented by individual Regional Water Boards. These permits are for the control of storm water runoff from: 1) industrial facilities; 2) construction sites; 3) municipalities; and 4) Caltrans existing highway system. The NPDES storm water permit program is implemented with an iterative process in which facilities implement best management practices and monitor and improve management practices, as monitoring data indicates the need.

The goal of the Storm Water Program is to prevent or minimize the discharge of pollutants contained in storm water runoff to waters of the state. Common pollutants contained in storm water runoff include:

- Sediment: construction or other activities expose and loosen soils, while vehicles break up pavement. Excessive sediment in water can affect the respiration, growth and reproduction of aquatic organisms, cause aesthetic impacts to receiving streams and affect spawning habitat of salmonids.
- Nutrients: Sources include fertilizer, lawn clippings, and car exhaust, which contain nutrients like phosphorous and nitrogen. An overabundance of nutrients can accelerate the growth of algae and affect the availability of DO.
- Heavy metals and toxic chemicals: Sources include cars (brake pads, engine wear, etc.), pesticides, and herbicides. Maintaining and cleaning transportation vehicles can release solvents, paint, rust, and lead. These chemicals may poison organisms or cause serious birth defects.

- Bacteria: Sources include failing septic tanks, sewer overflows, decaying organic material and the improper disposal of household pet fecal material. Some bacteria found in storm water runoff can result in disease. Beach closures result from high bacteria levels.
- Trash and litter: Sources include rural, urban, commercial, and industrial areas, highways, and parks. Trash is a significant pollutant that adversely affect beneficial uses including but not limited to uses that support aquatic life, wildlife and public health.

Land Disposal Program
The California Code of Regulations (CCR) Title 27 contains the regulatory requirements for treatment, storage, processing or disposal of solid wastes. The Land Disposal Program regulates the discharge to land of certain solid and liquid wastes. These wastes include designated wastes, nonhazardous solid wastes and inert wastes. In general, these wastes cannot be discharged directly to the ground surface without impacting groundwater or surface water, and therefore must be contained in waste management units (e.g., landfills) to isolate them from the environment.

Site Cleanup Program
The Site Cleanup Program (SCP) is designed to protect and restore water quality from spills, leaks, and similar discharges. The SCP program has several components at the North Coast Regional Water Quality Control Board:

- Complaint response
- Non-permitted discharge investigations
- Site cleanups under the oversight of the Regional Water Board
- Site cleanups pursuant to methods analogous to procedures in the Resource Conservation and Recovery Act
- Cleanups performed by local agencies.

Complaint response and investigations are coordinated with local agencies, and enforcement actions on non-permitted discharges may occur, either through coordination with the district attorney or through administrative processes of the Regional Water Board. Cleanups may be occurring voluntarily by responsible parties who have recognized the threat from non-permitted discharges. Voluntary or directed cleanups may occur under orders issued pursuant to section 13304 of the California Water Code (CWC), or through technical reports required pursuant to CWC section 13267. State Water Board Resolution 92-49 is the over-riding policy guiding the Regional Water Board's Spills Leaks, Investigations and Cleanup (SLIC) program.

Cleanup levels for soil are determined based on the threat to water quality. Such levels are determined on a case-by-case basis considering the nature of the contaminants, the type of soil, the depth to groundwater, distance to surface water, and other hydrogeologic characteristics. Cleanup levels for groundwaters and surface waters are determined based on application of existing laws, regulations, plans, and policies. In general, waters shall be cleaned up to: background, where feasible; to levels achievable through best available technology; and in all cases at least to water quality objectives. The appropriate water quality objective is determined based on the beneficial uses of waters. The water quality objective selected for a given receiving water is the objective protective of the most sensitive beneficial use.

For groundwater cleanup orders, staff applies footnote #2 to Table 3-2 of the Basin Plan (page 3-11), which states: "The values included in this table are maximum contaminant levels for the purposes of groundwater and surface water discharges and cleanup. Other water quality objectives (e.g., taste and odor criteria or other secondary MCLs) and policies (e.g., State Water Board "Policy With Respect to Maintaining High Quality Waters in California") that are more stringent may apply."

The State Water Board has developed, and updates regularly, a document entitled "A Compilation of Water Quality Goals," and an associated database of chemical constituent criteria developed by other federal or California state agencies. The State Water Board maintains the database, Water Quality Goals online[17], on its website which is freely available to all the regions and the public. It also publishes a searchable database and spreadsheet including numeric values recommended to implement selected water quality objectives as regular updates in the "Water Quality Goals" report. The numeric criteria represented in the database includes:

- Drinking water standards (a.k.a., MCLs) developed by the DDW
- Maximum Contaminant Level Goals (MCL goals or MCLG) developed by USEPA
- California Public Health Goals (PHGs) developed by California Environmental Protection Agency (Cal/EPA)
- California Drinking Water Notification and Response Levels developed by the DDW
- Cancer Potency Factors developed by the Office of Environmental and Human Health Assessment (OEHAA)
- Reference doses and cancer risk in drinking water as described in the Integrated Risk Information System (IRIS) developed by USEPA
- Drinking Water Health Advisories and Water Quality Advisories developed by USEPA
- Suggested No-Adverse-Response Levels (SNARLs) developed by the National Academy of Sciences
- Proposition 65 Safe Harbor Levels developed by OEHHA
- California Toxics Rule and National Toxics Rule values developed USEPA
- California Ocean Plan Objectives developed by the State Water Board
- National Recommended Water Quality Criteria developed by USEPA

[17] http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/

- Agricultural Water Quality Criteria developed by the Food and Agriculture Organization of the United Nations
- Taste and Odor Criteria developed by USEPA
- Other numeric criteria.

Staff uses this compilation, among other tools, to select the most appropriate numeric limit to protect the most sensitive beneficial use susceptible to impact from a given project or discharge. Staff regularly uses this resource for identifying the most protective threshold for chemical constituents or toxicity to protect human health or aquatic life when developing permits, orders and other regulatory actions for the protection of beneficial uses.

For narrative water quality objectives associated with sediment Regional Water Board staff developed the *Desired Salmonid Freshwater Habitat Conditions for Sediment-Related Indices* (July 2006), which includes desired conditions expressed through the following indices: benthic macroinvertebrate assemblage, embeddedness, large wood debris frequency and volume, pool distribution, substrate composition, thalweg profile, and V* percentage. Turbidity and D50 are also discussed.

The desired condition values are numeric in nature and are directly measurable by known monitoring methods. Therefore, they can provide a means of assessing attainment, or recovery toward attainment, with the narrative water quality objectives for suspended material, settleable material, and sediment in regards to salmonid freshwater habitat. The report satisfies and fulfills the direction from the Regional Water Board to complete a scientific document addressing salmonid freshwater habitat properly functioning conditions for sediment-related parameters. This direction was given to the Executive Officer on November 29, 2004, in Resolution No. R1-2004-0087, which established the *Total Maximum Daily Load Implementation Policy Statement for Sediment-Impaired Receiving Waters in the North Coast Region*.

2.2.2 Existing Program of Implementation for Dissolved Oxygen

The conceptual model for DO (Figure 1 in Appendix D) specifically identifies the following activities as influencing the presence of DO in an aquatic system: agricultural practices, forestry practices, fossil fuel extraction and refinement practices, other mining practices, construction practices, residential and commercial practices, recreational practices, and industrial practices. These activities have the potential to act as sources of: animal wastes, mining wastes, septic system leachate, landfill leachate, fertilizers, sewage treatment plant effluent, industrial effluent, industrial emissions, vehicle emissions, storm water discharge, fire ash and smoke, and other historic or existing sources. In addition, these activities have the potential to alter environmental conditions in such a way as to alter the natural cycle of DO availability. For example, the installation of impoundments, alteration of land and canopy covers, and alteration of the stream channel can impact or alter the natural pattern and range of DO in an aquatic system. Within this context, DO can be viewed as a response variable, reacting to the intersection of any number of other factors to result in ambient conditions which may or may not be supportive of existing beneficial uses.

Specifically, the conceptual model illustrates the importance of developing management measures designed to:

- Reduce the threat of discharge of anthropogenic sources of nutrients, and organic matter including the discharge of agricultural return flows,
- Reduce the threat of discharge of warm water to a waterbody, including the discharge of agricultural return flows;
- Reduce the threat of anthropogenic sources of erosion and sediment delivery;
- Reduce the threat of direct alteration of the stream channel, such as through gravel mining;
- Reduce the threat of disturbance to wetlands, the flood plain and riparian zone;
- Reduce the threat of anthropogenic alteration to the natural pattern and range of flows, including storm water management, groundwater protection, and control of water impoundment and withdrawal;
- Reduce the threat of loss or alteration (e.g., reduction in flow or increase in temperature) of cold water springs; and,
- Increase the availability of channel forming material (e.g., large woody debris) in the stream channel, riparian zone, and floodplain.

As described below, there are numerous existing programs of implementation that are designed to accomplish the goals as stated above in the conceptual model. As a general matter, the cornerstones of the existing regulatory programs are: 1) the waste discharge prohibition; 2) WDRs; and 3) waivers of WDRs. As an example of the waste discharge prohibition, the Regional Water Board prohibits the point source discharge of wastes to all the waters of the region except the Mad, Eel, and Russian rivers during the period of May 15 through September 30 and under specific flow regimes. The Regional Water Board can also issue new prohibitions to address specific water quality issues, as needed. For example, in 2010, the Regional Water Board adopted a prohibition against unauthorized discharges of waste that violate water quality standards in the Klamath River basin.

WDRs allow the discharge of waste to a water of the North Coast Region; but, they identify the pollutants of concern and the discharge limits necessary to ensure the protection of water quality, including compliance with the ambient water quality objectives and antidegradation policy of the Basin Plan. WDRs can be issued as individual permits (e.g., for a particular facility), group permits (e.g., for facilities within a particular watershed), or general permits (e.g., for facilities conducting a particular activity). The Regional Water Board also has the option to issue a waiver of requirements for facilities whose operations meet certain conditions if it is in the public interest.

In 1988, the State Water Board issued a Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program (Nonpoint Source Policy) outlining a three-tiered program by which nonpoint source pollution was to be controlled in the state. The first tier of the program called upon landowners to voluntarily comply with the Basin Plan, including compliance with water quality objectives. The Nonpoint Source Policy was updated in 2004 and more plainly made clear the obligation of the Regional Water Board to ensure compliance with the Basin Plan, even from nonpoint sources of pollution.

In 2000, the State Water Board developed a strategy for prioritizing those sources of nonpoint source pollution requiring immediate state attention. The "Plan for California's Nonpoint Source Pollution Control Program" (SWRCB 2000) identifies 6 categories of activities requiring priority management for the control of nonpoint source pollution in the state, including:

- Agriculture;
- Forestry;
- Urban areas;
- Marinas and recreational boating;
- Hydromodification; and
- Wetlands, riparian areas and vegetated treatment systems.

For these 6 categories of activities, the State Water Board (2000) further identifies 61 management measures to be implemented over a 15-year schedule, beginning in 1998. The Regional Water Board currently implements a number of programs that reasonably and adequately address water quality issues such as DO. These include programs designed to control:

- Point source discharge of waste to waters of the state either directly or via storm water. These discharges are regulated under NPDES program;
- Discharge of waste as a result of timber operations;
- Discharge of waste as a result of dredging, filling, or other activities that directly, indirectly, or cumulatively affect streams and wetlands that require Water Quality Certifications pursuant to CWA Section 401 (401 Certification Program);
- Discharges of waste to land;
- Total Maximum Daily Loads (TMDLs) for waterbodies listed as impaired on the CWA 303(d) list.

Timber Operations
The Regional Water Board has been regulating discharges from logging and associated activities since 1972. The North Coast Region includes 12% of the state's land area yet produces 40% of the private timber harvested within the state and 40% of the state's total runoff. Most of the public lands involved in timber harvest activities within the North Coast Region are under the jurisdiction of the U.S. Forest Service (USFS). The State Water Board

and the USFS entered into a Management Agency Agreement (MAA) in 1981 for overseeing water quality protection on National Forest System lands, including timber sales. The MAA requires the USFS to implement approved best management practices for water quality protection. In June 2010, the Regional Water Board adopted Order No. R1-2010-0029, Waiver of Waste Discharge Requirements for Nonpoint Source Discharges Related to Certain Federal Land Management Activities on National Forest System Lands in the North Coast Region. This order replaced a previous 2004 waiver that covered only timber harvesting operations (Order No. R1-2004-0015). The USFS must seek coverage under the 2010 Waiver prior to beginning timber harvest activities. Regional Water Board staff provides comments and conducts inspections on proposed timber sales and other projects to ensure USFS complies with the 2010 Waiver.

Timber harvesting activities have the potential to impact waters of the state by felling, yarding, and hauling of trees; constructing and reconstructing roads; constructing, reconstructing or removing watercourse crossings; applying herbicides and pesticides; broadcast burning; and other site preparation activities. Excessive soil erosion and sediment delivery associated with these activities can impact the beneficial uses of water by: silting over fish spawning habitat; clogging drinking water intakes; filling pools creating shallower, wider, and warmer streams; increasing downstream flooding; creating unstable stream channels; endangering wildlife; and losing riparian habitat. Timber harvesting in the riparian zone can adversely affect stream temperatures by removing stream shading, which is especially a concern for temperature impaired waterbodies. Removal of large diameter trees in the riparian zone also adversely affects the amount of large woody debris available for the development of the complex instream features necessary to provide food sources and refuge for juvenile and adult fish and stabilize the bed and banks of streams at a wide range of flows.

For private lands, the California Department of Forestry and Fire Protection (CALFire) is the lead agency responsible for regulating timber harvesting under the California Forest Practice Rules (FPRs). The State Water Board, State Board of Forestry, and CALFire entered into a Management Agency Agreement (MAA) in 1988 for overseeing water quality protection on Timber Harvest Plan (THPs). Under the MAA, the Regional Water Board is a responsible agency and plays an advisory role.

The FPRs require the submission and approval of a THP prior to starting most timber operations. Once a THP is submitted to CALFire, Regional Water Board staff reviews the plan as a "Review Team" member, along with the Department of Fish and Wildlife, California Geological Survey, and CALFire. The Regional Water Board has two roles in the review of timber harvest plans, non-industrial timber management plans (NTMPs), and other commercial timber harvest projects on private lands:

- The Regional Water Board issues WDRs and Waivers of WDRs (Waiver), which establish conditions or requirements to control discharges of waste to waters of the state.
- As a member of the CALFire Review Team the Regional Water staff also participates in pre-harvest inspections and submits comments and recommendations to CALFire to protect water quality and to avoid violations of Regional Water Board regulations.

Following plan approval by CALFire, and prior to beginning timber harvest activities, landowners must apply for coverage under: the General WDRs (Order No. R1-2004-0030); the Categorical Waiver (Order No. R1-2009-0038); the NTMP General WDRs (Order No. R1-2013-0005); an individual waiver or WDR; or in some cases a watershed-wide WDR.

Regional Water Board staff may also perform the following activities to protect the beneficial uses of water and regulate timber harvest activities: attend active and post-harvest inspections of approved plans; review Habitat Conservation Plans and Sustained Yield Plans; perform and review watershed analyses; participate in meetings of the Board of Forestry and CALFire; take enforcement actions and investigate complaints; assess conversions of timber lands to other land uses; and participate in TMDL development and implementation.

401 Certification
Anyone proposing to conduct a project that requires a federal permit or involves dredge or fill activities that may result in a discharge to federal waters and/or waters of the state is required to obtain a CWA Section 401 Water Quality Certification and/or Waste Discharge Requirements (Dredge/Fill Projects) from the Regional Water Board, verifying that the project activities will comply with state water quality standards. The most common federal permit for dredge and fill activities is a CWA Section 404 permit issued by the U.S. Army Corps of Engineers.

Section 401 of the CWA grants each state the right to ensure that the state's interests are protected on any federally permitted activity occurring in or adjacent to waters of the state. In California, the State Water Board (including its nine Regional Water Boards) is the agency mandated to ensure protection of the state's waters. So if a proposed project requires a U.S. Army Corps of Engineers CWA Section 404 permit, falls under other federal jurisdiction, and has the potential to impact waters of the state, the Regional Water Board can deny or certify the proposed project with conditions under CWA Section 401. The Regional Water Board will use USEPA's section 404(b)(1), "Guidelines for Specifications of Disposal Sites for Dredge or Fill Material, in determining the circumstances under which filling of waters of the state might be permitted.

However, if a proposed project does not require a federal permit, but does involve dredge or fill activities that may result in a discharge to waters of the state, the Regional Water Board has the option to regulate the project under Porter-Cologne Act in the form of WDRs or a Waiver.

The Regional Water Board will refer to the following for guidance when permitting or otherwise acting on dredge or fill projects:

- Governor's Executive Order W-59-93 (signed August 23, 1993; also known as the California Wetlands Conservation Policy);
- Senate Concurrent Resolution No. 28;
- California Water Codes section 13142.5 (applies to coastal marine wetlands).

The goals of the California Wetlands Conservation Policy include ensureing "no overall net loss," achieving a "long-term net gain in the quantity, quality, and permanence of wetlands acreage and value…", and reducing "procedural complexity in the administration of state and federal wetlands conservation programs."

Senate Concurrent Resolution No. 28 states, "It is the intent of the legislature to preserve, protect, restore, and enhance California's wetlands and the multiple resources which depend on them for the benefit of the people of the state."

California Water Code section 13142.5 states, "Highest priority shall be given to improving or eliminating discharges that adversely affect…wetlands, estuaries, and other biological sensitive sites."

In addition, California Department of Fish and Wildlife (CDFW) may regulate the project through the Streambed Alteration Agreement process. CDFW issues Streambed Alteration Agreements when project activities have the potential to impact intermittent and perennial streams, rivers, or lakes.

Total Maximum Daily Loads
The Regional Water Board develops and implements TMDLs for water bodies listed as impaired on the 303(d) list. Waterbodies listed as impaired due to reduced DO are detailed in Section 1.3.2 of this staff report. The final 2012 305(b) and 303(d) Integrated Report is available at:
http://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/303d/

The Regional Water Board has approved a TMDL for DO in the Shasta River, including an implementation plan. Additionally, in 2010 the Regional Water Board approved a TMDL for the Klamath River including 1) Site Specific Dissolved Oxygen Objectives for the Klamath River; (2) an Action Plan for the Klamath River TMDL addressing temperature, DO, nutrient, and microcystin impairments in the Klamath River; and (3) an Implementation Plan for the Klamath and Lost River Basins.

Summary
There are a number of existing State Water Board policies that, in addition to Basin Plan requirements, are implemented for the protection of human health and aquatic life including the State Water Board Resolutions No. 68-16 (Antidegradation), No. 88-63 (Sources of Drinking Water), and No. 92-49 (Cleanup and Abatement Policy). In addition, there are numerous existing programs of implementation addressing the actions needed to treat wastewater and storm water prior to its discharge to waters of the state, as well as programs established to remediate pollution from discharges to state waters. Each of these existing programs has its own evolving and improving set of actions needed to achieve compliance with water quality objectives. As best available technologies improve, so too do the efficiencies in cost and program implementation. In addition, each of these existing programs includes general, site-specific, or project-specific time schedules for which compliance will be met. Finally, each the existing programs described above has a variety of monitoring and reporting requirements in order to demonstrate compliance with water quality objectives.

2.3 Water Quality Conditions that Could Reasonably be Achieved

As discussed above in Section 2.2, various programs of implementation exist to address chemical constituents, toxicity and dissolved oxygen. Implementation programs span both point source and nonpoint source activities and discharges. Through the coordinated control of factors, water quality in the North Coast has been preserved, maintained and restored in an enumerable amount of cases from groundwater remediation success stories to wastewater treatment systems infrastructure upgrades to stream habitat improvement projects. Therefore, it is reasonable to expect that the water quality objective amendment will result in the continuation of this pattern. Spills, leaks, accidents and treatment system failures will likely continue to lead to violations of water quality objectives. However, with well-established regulatory programs, public support, stakeholder engagement and strengthening partnerships the North Coast Region can reasonably expect the continued preservation, maintenance and restoration of water quality.

TMDL source control programs, watershed stewardship activities, groundwater assessments at basin scale, and wastewater treatment programs will promote proactive approaches to maintain and achieve water quality standards. Additionally, key programs such as cleanups and watershed restoration will continue to operate to restore polluted or impaired waters of the state to levels that support beneficial uses. Therefore, regulatory actions following the anticipated adoption of this amendment will yield requirements equivalent to that which results from current regulatory practices and to that which is necessary for the reasonable protection of beneficial uses.

3. Draft Revisions to Basin Plan Section 3 (Water Quality Objectives)

This chapter of the Staff Report presents the rationale for the recommended revisions to Section 3 of the Basin Plan (Water Quality Objectives). The actual draft language is included in Appendices A and C (strikethrough/underline copy and clean copy, respectively). As needed for clarity, excerpts of the draft language are included in the discussion below. Many of the water quality objectives described in Section 3 were developed in the 1970s or 1980s and have not been revised since. Some of these are outdated, with respect to the findings of current scientific literature.

This draft amendment seeks to clarify the longstanding procedures for implementing water quality objectives within the framework of the Basin Plan so as to provide regulatory transparency. The goal of the draft revisions is to elaborate on existing authorities so as to make clear and transparent the process staff has been using and will continue to use when identifying the most appropriate numeric threshold when protecting beneficial uses.

Below is a general explanation for the proposed major revisions, including revisions to the objectives for chemical constituents, revisions to the dissolved oxygen objective, and the inclusion of a narrative groundwater toxicity objective. A more detailed discussion follows for each of the proposed revisions, including editorial and other minor proposed alterations.

3.1 Chemical Constituents

The existing water quality objectives for chemical constituents do not reflect current scientific understanding for all parameters. The objectives for chemical constituents apply to surface water and groundwater, both of which can be sources of drinking water and can support numerous other beneficial uses. The specific objectives of numeric chemical constituents contained in the Basin Plan are the drinking water standards developed by the California Department of Public Health (CDPH), now the State Water Board Division of Drinking Water (DDW) and described in the California Code of Regulations, Title 22, at the time the objectives were adopted in 1975 and modified in 1993, which are now outdated.

These drinking water standards, also known as Maximum Contaminant Levels (MCLs), do not include consideration of other human health exposures (e.g., contact, recreation or fish consumption), aquatic life exposures (e.g., migration, feeding, and early development exposures), or agricultural crop impacts (e.g., plant growth interference or increased mortality) despite the fact that these other beneficial uses are designated for surface water and groundwater in the North Coast Region. Furthermore, while the existing objectives for chemical constituents specify numeric values for MUN and a general narrative objective for AGR, the existing objectives are silent on values to protect uses other than MUN and AGR. With respect to these beneficial uses, ambient groundwater quality conditions must not result in exceedances of agricultural crop criteria or human health exposure criteria for drinking water.

Water quality objectives, on the other hand, are intended to describe the ambient water quality condition necessary to support and maintain all beneficial uses. Other beneficial uses of water that may be more sensitive to chemical exposures than MUN and AGR include, but are not limited to: COMM, SHELL, FISH, CUL, COLD, SPWN, WILD and RARE (See Section 1.1 of this staff report for more discussion on Beneficial Uses). The absence of explicit language in the objectives for chemical constituents with respect to beneficial uses other than AGR and MUN does not abrogate the Regional Water Boards authority nor nullify the applicability of objectives for chemical constituents to protect other beneficial uses.

All surface and ground waters of the state are considered to be suitable, or potentially suitable, for municipal or domestic water supply and should be so designated by the Regional Water Board except those excluded by the State Water Board Resolution No. 88-63, Sources of Drinking Water Policy. Individual water supplies commonly include the use of raw untreated groundwater and to a lesser extent include raw untreated surface water. The MUN use must be supported by objectives that protect beneficial uses and prevent nuisance (Wat. Code § 13241) independent of treatment by a water supplier**.**

The existing objective for chemical constituents is both narrative and numeric. The first portion applies MCLs as the upper most limits to waters with the municipal and domestic water supply (MUN) beneficial use. The section portion is narrative and protects from adverse impacts to the agricultural beneficial use. The third portion applies waterbody-specifc objectives, as listed in Table 3-1, for specific conductance, total dissolved solids (TDS), DO, pH, hardness, and boron.

Therefore, the draft revisions to the objectives for chemical constituents include:

1. Revising the narrative objectives for chemical constituents to clearly apply to the protection of all beneficial uses, not just AGR.
2. Adding language regarding the prevention of nuisance, as required in Porter-Cologne.
3. Deleting the outdated Table 3-2, *Inorganic, Organic, and Fluoride Concentrations Not to be Exceeded in Domestic or Municipal Supply*.
4. Prospectively incorporating the Primary and Secondary MCLs listed in California Code of Regulations, Title 22 as the minimum water quality objectives for chemical constituents to protect the MUN beneficial use.

To further elaborate, the drinking water standards described in Title 22 as referenced above, are given as primary MCLs and secondary MCLs. Primary MCLs are health protective drinking water standards to be met by public water supply systems. Secondary MCLs are established to be protective of aesthetic or nuisance conditions such as taste, odor and color. Primary MCLs take into account not only the health risks of chemicals, but also factors such as their detectability and treatability including:

> "the costs of compliance to public water systems, customers, and other affected parties with the proposed primary drinking water standard, including the cost per customer and aggregate cost of compliance, using best available technology".[1]

MCLs are required to be established at a level no less stringent than the primary drinking water standards established by the United States Environmental Protection Agency's (USEPA) and as close to the established public health goal (PHG) as is technologically and economically feasible [2]. PHGs are established by California Environmental Protection Agency's (Cal/EPA) Office of Environmental Health Hazard Assessment (OEHHA). PHGs are concentrations of drinking water contaminants that pose no significant health risk if consumed/exposed for a lifetime, based on current risk assessment principles, practices, and methods. OEHHA establishes PHGs for contaminants with MCLs, and for those for which MCLs will be adopted[3]. However, due to the economic factors for public water systems and aggregate costs using best available technology, many MCLs are established at levels well above PHGs.

3.2. Groundwater Toxicity

Regional Water Board staff has identified the need to develop language that clearly articulates the process, required by existing state and federal law, that staff utilizes when translating narrative water quality objectives into numeric values to be implemented in permits, orders, and other regulatory actions. The development of the clarifying language is an attempt to reduce confusion and disagreement on Regional Water Board implementation of water quality objectives.

Regional Water Board staff has relied on alternative justifications and authority for establishing cleanup levels and permit limits to address toxic constituents of concern, such as the federal and state antidegradation policies and State Water Board's Resolution 92-49 *Policies and Procedures for Investigation and Cleanup and Abatement of Discharges under Water Code section 13304* (Cleanup Policy). The Cleanup Policy directs cleanup and abatement activities to be performed in a manner that either achieves background water quality, or the best water quality which is reasonable taking all demands being made and to be made on those waters and the total values involved. In practice, attainment of background is not feasible in many cases and the cleanup goals are rarely set to background in the North Coast Region.

Section 3 of the Basin Plan, which lists objectives for chemical constituents, includes an introductory section and footnote 2 in Table 3-2, which explicitly states,

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[1] California Health & Safety Code section 116365 subdivision(b)(3)
[2] California Health & Safety Code section116365 subdivision (b)
[3] California Health & Safety Code section 116365 subdivision (c)

"Other water quality objectives (e.g. taste and odor thresholds or other secondary MCLs) and policies (e.g., State Water Board "Policy With Respect to Maintaining High Quality Waters in California") that are more stringent may apply".

The Regional Water Board has relied on footnote 2 to Table 3-2 and the existing State Water Board policies to establish the most protective and attainable cleanup goal, often lower than the MCL. The Regional Water Board regularly adopts discharge permits and orders that implement taste and odor criteria as currently listed in Title 22, PHGs, and aquatic life criteria that are more stringent than current MCL values. Adopting a specific groundwater toxicity objective will provide a more sound and more transparent regulatory standard to address the cleanup of toxic substances in groundwater for the protection of human health and the environment. However, adding the toxicity objective for groundwater will not fundamentally alter the limits that are included in future permits, orders, and other regulatory actions compared to the limits that have been included in existing permits to date using existing authorities and alternative justifications.

At issue is that in some cases, the MCL is significantly higher than the *de minimis* risk level (1-in-a-million increased cancer risk) for a carcinogen. As one example, the primary MCL (both California and Federal) for tetrachloroethane (a.k.a. perchloroethylene or PCE) is 5 micrograms per liter (µg/L), while the *de minimis* risk level set by OEHHA with its public health goal is 0.06 µg/L. As such, other toxicity numeric criteria, such as the cancer potency factors developed by OEHHA, may provide greater protection of drinking water for some constituents than does application of the MCL.

The existing Water Quality Objective for Taste and Odor provides another example of the logic for adopting a groundwater toxicity objective and clarifying how water quality objectives are implemented:

> *Waters shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin, or that cause nuisance or adversely affect beneficial uses.*
>
> *Numeric water quality objectives with regards to taste and odor thresholds have been developed by the State Department of Health Services and the U.S. EPA. <u>These numeric objectives, as well as those available in the technical literature, are incorporated into waste discharge requirements and cleanup and abatement orders as appropriate.</u>*

The language included in this objective furthers the point that staff uses numeric values from other sources as appropriate. When developing permits, orders and other regulatory actions, Regional Water Board staff identifies the numeric values necessary to protect the most sensitive beneficial uses of the water in question.

3.3. Dissolved Oxygen

The draft revision to the Dissolved Oxygen (DO) objectives is intended to: 1) better protect sensitive aquatic organisms from depressed DO; 2) better ensure that the natural pattern and range of DO variation is maintained in those waterbodies unable to meet the aquatic life-based objectives due to natural conditions; and 3) reduce the possibility that natural variation in DO is erroneously identified as DO impairment. It is possible that more waterbodies will be listed on the 303(d) list for impairment of DO conditions due to this revision. But, it is also likely that fewer waterbodies will be erroneously listed.

The aquatic life-based objectives are designed for the protection of sensitive aquatic organisms in fresh, free-flowing waters. They are generally based on laboratory studies in which ambient water quality conditions are controlled, so as to test individual variables. The draft objectives are designed, according to USEPA's DO criteria document (USEPA 1986), to ensure no production impairment. USEPA (1986) also suggests criteria that allow slight production impairment or moderate production impairment. The "no production impairment" criteria were chosen because of the number of key aquatic organisms in the North Coast Region that are listed by state and/or federal natural resource agencies as threatened or endangered.

Natural conditions that might prevent the attainment of aquatic life-based objectives include such things as: naturally high primary production, naturally ephemeral flow conditions, wetland conditions, or estuarine conditions. It also includes conditions of altitude and natural temperature that may physically preclude the attainment of high DO conditions, even with 100% DO saturation. A natural conditions clause is also proposed which is accompanied by a method for numerically calculating the natural pattern and range of DO in fresh, free-flowing waters. The draft DO objective also includes a narrative DO objective for estuaries.

Regional Water Board staff has prepared the *Peer Review Draft Staff Report for the Revisions of Dissolved Oxygen Water Quality Objectives*, March 2009 (Appendix E), which has undergone scientific peer review, as required by law. The two reviewers generally concurred with the scientific assumptions, assertions, and conclusions that this revision to the DO objective reflects, although each had suggestions for strengthening the discussion and expanding the scope of the amendment. Staff provided responses to the peer review comments (Appendix F) including explanations for those recommendations that were viewed as out of the scope of the proposed amendment. Staff also revised the recommendations in the peer review draft staff report based on peer review comments, when applying the principles of the approach to the development of site specific DO objectives for the Klamath River mainstem. The modeling conducted of conditions in the Klamath River, which formed the basis for adopted site specific DO objectives, informs this draft regionwide objective for DO. Most notably, the Klamath River modeling indicated that while 85% DO saturation (under natural temperatures) reasonably represents natural dry season conditions, 90% DO saturation (natural temperatures) better represents natural wet season conditions. The peer reviewers' specific comments and Regional Water Board staff's response can be found in Appendix F of this document. Key elements of the staff report for the Proposed Site Specific Dissolved Oxygen Objectives for the Klamath River in California (2010) are included in Appendix E. The full report can be found on the Regional Water Board's website at http://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/klamath_river/100927/staff_report/13_Appendix1_Site-SpecificDOObjStaffReport.pdf

Regional Water Board staff recommends a revision to the existing dissolved oxygen objectives. The draft revision includes eliminating the column with site specific DO objectives from Table 3-1; moving the daily minimum DO objectives for Bodega Bay, Humboldt Bay, and ocean waters to a location under the "Dissolved Oxygen" objectives heading; and retaining the site specific objectives for the Klamath River which are contained in Table 3-1a. The draft revision also includes retaining the existing daily minimum aquatic life objectives for WARM, MAR, SAL, and COLD. It modifies the SPWN daily minimum objective by eliminating the less protective objective (7.0 mg/L), retaining the more protective objective (9.0 mg/L), and expanding the applicability of the more protective objective to the entire period during which eggs are in the intergravel environment, from spawning through emergence. As described in peer review draft staff report (Appendix E), this period is generally understood to come as early as September 15th and last as late as June 4th.

The draft revision also includes adding 7-day average DO objectives for the protection of WARM, COLD, and SPWN beneficial uses. The draft average objectives are based on ensuring no production impairment to threatened and endangered species as a result of DO deficiencies, as defined by USEPA in its DO criteria document from 1986. This is a 6.0 mg/L 7-day average for WARM waters, 8.0 mg/L for COLD waters, and 11.0 mg/L for SPWN waters during spawning, incubation through emergence. The 7-day average is a rolling average of the daily average.

To address other unnamed estuaries, the draft revision includes a narrative objective for estuaries that ensures that the DO in estuaries is not depressed to levels adversely affecting beneficial uses as a result of controllable water quality factors.

Finally, the draft revision allows for the Executive Officer to approve the application of adjusted DO objectives based on natural temperatures and altitudes as shown in Figure 3-2. Other natural conditions that could preclude attainment of aquatic life objectives include, but are not limited to: naturally nutrient-rich waters, ephemeral conditions, and others. Therefore, waterbody-specific DO objectives can be developed by calculating the minimum DO necessary to maintain 85% DO saturation in the dry season and 90% DO saturation in wet season.

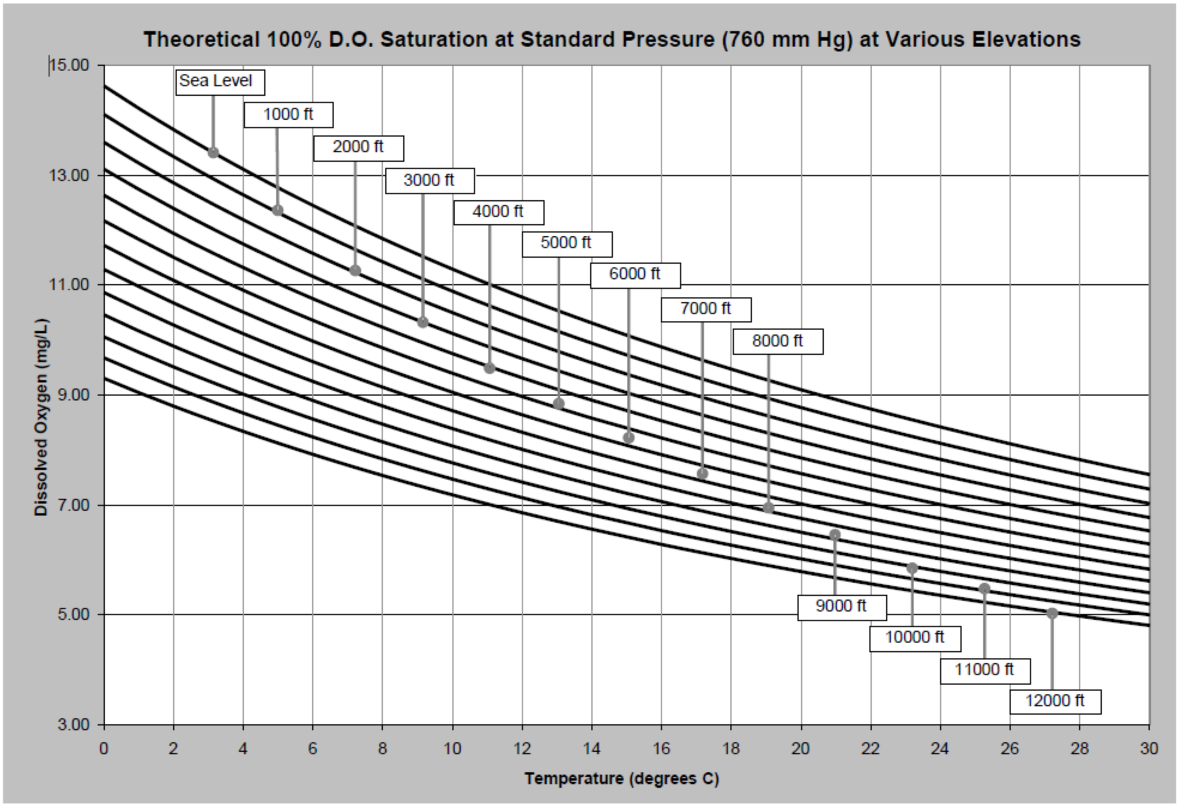

Figure 3-1 Theoretical DO at 100% Saturation (produced by Rich Fadness of the Regional Water Board)

3.4. Revisions to the Introduction

Various substantive and editorial changes are proposed for the introductory section including:

- Addition of explanatory language generally describing narrative and numeric water quality objectives.
- Addition of a footnote clarifying that the terms “designated use” and “water quality criteria” are based in federal law.
- Addition of a footnote clarifying that “beneficial use” and “water quality objectives” are terms derived from state law.
- Relocation of the existing text describing controllable factors to its own section in Chapter 4. In addition, the phrase “human caused” will be substituted for “man caused.”
- Deletion of outdated or redundant text such as the reference to expired waivers, the description of classes of water (which is presented in Chapter 2 – Beneficial Uses) and the superseding of water quality objectives contained in earlier editions of the Basin Plan.
- Removal of references to appendices no longer proposed for inclusion in the Basin Plan.

- Addition of new sub-section describing terminology for water quality standards.
- Addition of new sub-section describing terminology for water quality objectives and effluent limitations.
- Other minor editorial changes, such as capitalization, punctuation, grammar, and other minor revisions to improve clarity.

3.4.1 Water Quality Objectives

A revision to the Water Quality Objectives subsection is a key element in the proposed WQO Update Amendment, as this section includes new draft language regarding the selection of appropriate criteria to implement narrative objectives. Implementation of water quality objectives is a dynamic process which takes into account the complexity of the discharge of pollutants, site-specific factors that affect water quality and the existing laws and regulations. To determine whether a particular waste management activity or discharge may cause or threaten to cause adverse effects on water quality, it is necessary to review the beneficial uses and apply both narrative and numeric water quality objectives. As noted throughout this Staff Report, numeric objectives may include values derived from MCLs, CTR, or other general or specific scientific research of literature review (e.g., USEPA criteria guidance documents or watershed-specific data analyses). Narrative objectives include descriptions of conditions that are protective of beneficial uses, which in turn require the selection of appropriate and scientifically defensible numeric values to implement.

As previously noted, all relevant statewide policies must be implemented including the state and federal antidegradation policies and state Cleanup Policy. Together these policies establish natural background as the desired condition or the best water quality that is attainable considering social, economic and technical factors. Regardless of all factors, water quality may not be degraded to levels less than prescribed in Basin Plans. Figure 3-2 below is a general illustration of how MCLs, CTR, NTR and other water quality objectives are considered the “ceiling” in preventing pollution while natural background and zero concentrations represent the “floor”. In between these values are numerous other values that may represent toxicity to humans, taste and odor impairments, nuisance or other criteria relevant to the protection of beneficial uses.

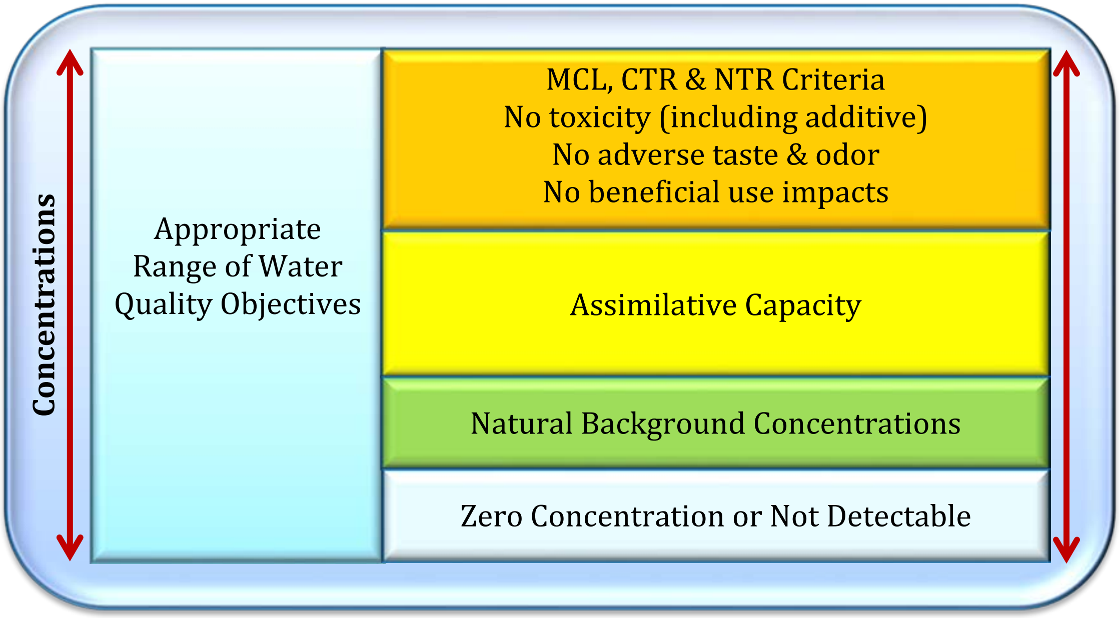

Figure 3-2. This schematic generally depicts the potential range of water quality objectives. It must be noted that some MCLs are at concentrations lower than some CTR, NTR, and taste and odor criteria. The specific criteria chosen depend on the most sensitive beneficial use being considered.

When staff recommends a constituent value for inclusion in a permit, cleanup order, or other board action, staff must first select the value that protects the beneficial uses of water, including the use that is most sensitive to the constituent of concern. Often the most sensitive beneficial use is related to aquatic species protection as aquatic species are frequently affected by lower levels of a given chemical constituent than that required for drinking water supply protection. In other cases, isolated plumes of contaminated groundwater may not pose a threat to surface waters and aquatic ecosystems. In such a case, the most sensitive beneficial use might be a domestic water supply well from which water is used untreated. While existing authorities allow the Regional Water Board to establish natural background conditions as the presumptive cleanup level, the Regional Water Board sometimes identifies levels protective of human health as more reasonable and feasible. The value that protects the most sensitive use is then used to derive the numeric limits used in permits, cleanup orders, or other regulatory actions as appropriate. Implementation of narrative water quality objectives requires staff to identify applicable sources for relevant numeric values that are appropriate for protecting beneficial uses. This list includes, but is not limited to, the following:

- United States Environmental Protection Agency (USEPA)
- California State Water Resources Control Board (State Water Board)
- California Department of Public Health, now the State Water Board Division of Drinking Water (DDW)
- California Office of Environmental Health Hazard Assessment (OEHHA)

- California Department of Toxic Substances Control (DTSC)
- University of California Cooperative Extension (UCCE)
- California Department of Fish and Wildlife (CDFW)
- United States Food and Drug Administration (USFDA)
- National Academy of Sciences (NAS)
- United States Fish and Wildlife Service (USFWS)
- Food and Agricultural Organization of the United Nations (UNFAO)
- World Health Organization (WHO)

The State Water Board has compiled numeric water quality values from the literature for over 860 chemical constituents in a document entitled *A Compilation of Water Quality Goals*. A searchable *Water Quality Goals* database is accessible on the State Water Board website. The Water Quality Goals staff report contains information to help users to understand California's water quality objectives adopted to protect the beneficial uses of surface water and groundwater resources, available criteria and guidance for evaluating water quality, and to help users select defensible numeric values based on applicable water quality standards. To use this information correctly, it is necessary to read *Selecting Water Quality Goals* carefully before using numeric criteria from the database. It is also important to note that it is the main principal of this document which applies and not necessarily the numbers in the staff report or database. In other words, the most important parts of the document are the established algorithms or process for identifying water quality objectives to protect beneficial uses. Of secondary importance, though highly relevant, are the sources of numeric values that protect beneficial uses. While the database may produce numeric values, it is prudent to double check the sources of those values for any potential updates or changes. Narrative objectives that are translated through this step-wise process include, but are not limited to, chemical constituents, pesticides, sediment, toxicity, and radioactivity. An outline of this process is provided below in Figure 3-3.

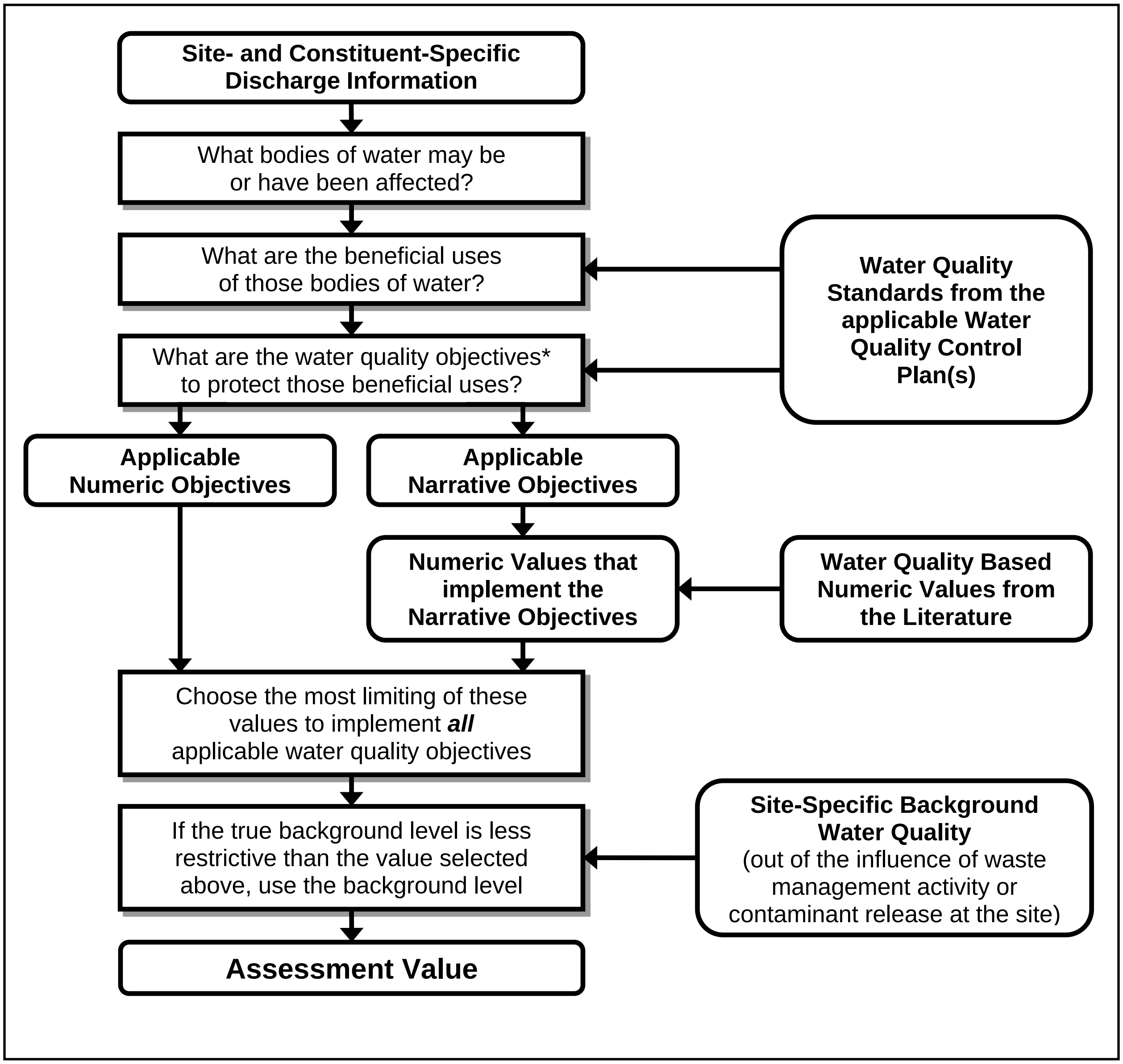

Figure 3-3. Numeric Value Selection Process for Narrative Water Quality Objectives[4]
*Practical quantitation limits are based on current technology. Some WQOs are below reasonable analytical equipment detection limits, and in those cases the practical quantitation limit is used as the WQO.

[4] Adapted from the State Water Board's *A Compilation of Water Quality Goals*, 16th Edition, April 2011

For an additional source of numeric criteria for sediment, the Regional Water Board has compiled water quality values from the literature for sediment-related indices and published them in a peer-reviewed report entitled *Desired Salmonid Freshwater Habitat Conditions for Sediment-Related Indices* (July 2006). This document can be found on the Regional Water Board website.

Other regional water boards including the San Francisco Bay Region, Central Coast Region, Central Valley Region, and Lahontan Region have adopted similar policies or clarifying language into their Basin Plans that either explain the method for selecting applicable numeric values for implementing narrative water quality objectives or cite the *Compilation of Water Quality Goals* and other relevant sources of information necessary to implement water quality standards.

3.4.2 Water Quality Objectives vs. Effluent Limitations

It is important to distinguish the difference between effluent limitations and water quality objectives. Again, a water quality objective is a numeric value or a narrative statement both of which describe a condition of ambient water quality necessary to protect beneficial uses. When implementing state and federal authorities in permits, orders, and other regulatory actions, it is first necessary to identify the existing beneficial uses and then translate all applicable narrative objectives into numeric values. It is also important to note the term Water Quality Standards is a federal term that includes water beneficial uses, water quality objectives, and antidegradation.

The Clean Water Act (CWA) addresses the conversion of narrative objectives into effluent limitations:

CFR Title 40, Section 122.44(d) Water Quality Standards and State Requirements
(6) Where a State has not established a water quality criterion for a specific chemical pollutant that is present in an effluent at a concentration that causes, has the reasonable potential to cause, or contributes to an excursion above a narrative criterion within an applicable State water quality standard, the permitting authority must establish effluent limits using one or more of the following options:

> (A) Establish effluent limits using a calculated numeric water quality criterion for the pollutant which the permitting authority demonstrates will attain and maintain applicable narrative water quality criteria and will fully protect the designated use. Such a criterion may be derived using a proposed State criterion, or an explicit State policy or regulation interpreting its narrative water quality criterion, supplemented with other relevant information which may include: EPA's Water Quality Standards Handbook, October 1983, risk assessment data, exposure data, information about the pollutant from the Food and Drug Administration, and current EPA criteria documents; or

(B) Establish effluent limits on a case-by-case basis, using EPA's water quality criteria, published under section 304(a) of the CWA, supplemented where necessary by other relevant information; or

(C) Establish effluent limitations on an indicator parameter for the pollutant of concern, provided:

(*1*) The permit identifies which pollutants are intended to be controlled by the use of the effluent limitation;

(*2*) The fact sheet required by § 124.56 sets forth the basis for the limit, including a finding that compliance with the effluent limit on the indicator parameter will result in controls on the pollutant of concern which are sufficient to attain and maintain applicable water quality standards;

(*3*) The permit requires all effluent and ambient monitoring necessary to show that during the term of the permit the limit on the indicator parameter continues to attain and maintain applicable water quality standards; and

(*4*) The permit contains a reopener clause allowing the permitting authority to modify or revoke and reissue the permit if the limits on the indicator parameter no longer attain and maintain applicable water quality standards.

As noted above one option is to establish effluent limits on a case-by-case basis, using USEPA water quality criteria, supplemented where necessary by other relevant information. Another option in the NPDES wastewater program is described in the SIP for priority pollutants in surface waters. However, the SIP does not address all potential pollutants in all waste streams or in all circumstances and is therefore periodically augmented with criteria or numeric values from other relevant and credible sources.

Staff has consistently interpreted the SIP and State Water Board Resolution Nos. 68-16 and 92-49 to allow the establishment of numeric limits in order to protect the applicable and most sensitive beneficial use by using relevant sources other than the existing water quality objectives in the Basin Plan. As noted in the Basin Plan, SIP, State Administrative Procedures Manual (APM), and as specified in Water Code section 13263 subdivision (b),

> "a regional board, in prescribing requirements, need not authorize the utilization of the full waste assimilation capacities of the receiving waters".

Therefore, staff can establish effluent limitations or cleanup levels in Regional Water Board orders lower than the established water quality objectives in order to maintain water quality supportive of beneficial uses and assimilative capacity of the receiving waters.

3.5 General Organizational and Editorial Changes

Major portions of the Basin Plan are currently identified as "sections" within the table of contents and the text of the Basin Plan. No numbering system is currently applied to the subsections contained in these "sections." As part of this amendment, staff proposes to replace the term "section," where appropriate, with "chapter" to clearly indicate the overall framework of the Basin Plan. Sections and subsections are used as appropriate, and a numbering system is introduced to identify individual parts within each chapter for the user's convenience. This is consistent with formatting revisions made to Chapters 1 and 2 of the Basin Plan during earlier editorial amendments.

The current page numbering system used in the Basin Plan (e.g., "3-9.00" and "3-10.00.") was implemented to accommodate updating of hard copy Basin Plans on a page-by-page basis before the routine utilization of computer technology. The use of this expanded numbering system allowed a new page to be easily inserted between existing pages (e.g., "3-9.01") without having to repaginate the remaining portion of the Basin Plan. This expanded numbering system has not been used in the North Coast Region's Basin Plan for several revisions. As part of this amendment, staff proposes to replace this numbering scheme with a "3-x" format.

3.5.1 Revisions to the "Antidegradation Policies" Section

This section discusses the state and federal antidegrdation policies. The header "General Objective" will be retitled "Antidegradation Policies." The inclusion of the commonly used phrase "antidegradation" in the section heading will make it easy for the user to locate this section in either hard copy or electronic format.

Minor editorial changes are proposed by staff to improve the clarity and readability of the Antidegradation Policies section. Substantive public comments were received in early February 2012, requesting several additional changes to the Antidegradation Policies section. Given the larger scope of the additional requested revisions, and the current statewide effort examining the state Antidegradation Policy with respect to its application to groundwater, staff has instead placed review and update of the content contained in the antidegradation discussion of the Basin Plan on the 2014 Triennial Review list and prioritized for future Basin Plan amendment.

In addition to the editorial changes, staff proposes at this time to remove existing language referring readers to the Antidegradation Policies as Appendices 6 and 6B of the Basin Plan and refer the reader, instead, to the State Water Board website. This is the approach staff recommends for all state policies now appended to the Basin Plan, as a way of ensuring the reader is directed to the most up-to-date information. Advances in technology make inclusion of these documents as appendices to the Basin Plan unnecessary as they are easily accessed via the internet.

3.5.2 Revision to Water Quality Objectives for Surface Waters

The Water Quality Objectives for surface waters section contains seventeen water quality objectives that apply to the protection of surface waters in the Region. Nine of these objectives require minor revisions for the reasons detailed below. Additionally, the objectives will be rearranged and presented in alphabetical order for the user's convenience.

3.5.3 Revisions to "Objectives for Ocean Waters" Section

Staff recommends that the "Objectives for Ocean Waters" heading be changed to "Water Quality Objectives for Ocean Waters" for consistency. In addition, reference to the *Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California* (Thermal Plan) in the appendix section of the Basin Plan is revised to direct the reader to the State Water Board's website.

3.5.4 Revisions to "Objectives for Inland Surface Waters, Enclosed Bays, and Estuaries" Section

The introductory language in this section is revised to include a reference to the State Water Board *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries* (SIP) to inform the reader that this policy is applicable to waters in the North Coast Region. This revision is consistent with the information on applicable state plans and policies presented in the section on ocean waters. References to the National Toxics Rule (NTR) and the California Toxics Rule (CTR) are added to inform the reader that these regulations are applicable to waters in the North Coast Region as well as adding a statement that these regulations address human health and aquatic life protection. References to the other tables containing site-specific objectives (i.e., Tables 3-1a and 3-1b) will be added after the reference to Table 3-1. Other minor editorial revisions, such as revision to the heading for consistency with other headings, are also proposed to improve readability.

3.5.5 "Bacteria" Objective

A minor editorial change from the State Department of Health Services to the State Water Board Division of Drinking Water is the only proposed modification to the objective for bacteria. No substantive revisions to the bacteria objective are proposed as part of this amendment. Significant substantive revisions are required to appropriately update this objective. Such revisions have been postponed until an objective with statewide applicability is adopted by the State Water Board as part of their ongoing effort to update freshwater bacteria standards for the protection of recreation. The statewide effort does not include consideration of bacteria objectives appropriate for the protection of shellfish harvesting (SHELL).

The issue of updating the bacteria objective for surface waters has been included on the Triennial Review list since 2001 and its importance was reaffirmed on the 2011 Triennial Review list.

3.5.6 "Biostimulatory Substances" Objective

No revisions proposed to the existing language.

3.5.7 "Color" Objective
No revisions proposed to the existing language.

3.5.8 "Floating Material" Objective
No revisions proposed to the existing language.

3.5.9 "Oil and Grease" Objective
No revisions proposed to the existing language.

3.5.10 Revisions to "Pesticides" Objective
The narrative portion of this objective will be maintained and will include new language regarding the prevention of nuisance. References to Title 22 will be modified to keep consistent with prospective updates referenced under the objective for chemical constituents. Table 3-2 will be deleted.

3.5.11 Revisions to "pH" Objective
Minor revisions proposed for the pH objective include removal of the word "designated" and the use of complete beneficial use names (e.g., inland saline water habitat), along with abbreviations (SAL), instead of abbreviations alone. Elimination of the word "designated" is necessary to make clear that all existing beneficial uses are protected, whether or not they are listed in Table 2-1 as "designated." Complete beneficial use names will be added throughout the draft amendment as appropriate.

3.5.12 Revisions to "Radioactivity" Objective
The narrative portion of this objective will be maintained and will include new language regarding the prevention of nuisance. References to Title 22 will be modified to keep consistent with prospective updates referenced under the objective for chemical constituents. Table 3-2 will be deleted.

3.5.13 "Sediment" Objective
No revisions proposed to the existing language.

3.5.14 "Settable Material" Objective
No revisions proposed to the existing language.

3.5.15 "Suspended Sediment" Objective
No revisions proposed to the existing language.

3.5.16 Revisions to "Tastes and Odors" Objective
The narrative portion of this objective will be maintained. References to Title 22 will be modified to keep consistent with prospective updates referenced under the objective for chemical constituents.

References to numeric water quality objectives established by Department of Health Services and the U.S. EPA, as well as the reference to waste discharge requirements and other orders, will be removed from this objective to provide a more concise definition.

3.5.17 Revisions to "Temperature" Objective

Minor revisions to the existing temperature objective are proposed to improve readability and correct outdated information. The reference to the State Water Board's *Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays of California* as an appendix to the Basin Plan will be deleted. Instead, the reader will be referred to the State Water Board website as state plans and policies will no longer be included as appendices to the Basin Plan. A reference to the existing site-specific temperature objectives for the Upper Trinity River is also proposed for inclusion in the objective to provide clarity to the user.

3.5.18 Revisions to "Toxicity" Objective

The existing toxicity objective for surface waters will be refined to clarify that the objective applies regardless of whether the toxicity is caused by a single substance or the interactive effect of multiple substances. This language is similar to the language used in the Central Valley Region Basin Plan (Region 5).

In addition, the reference to a specific edition of *Standard Methods for the Examination of Water and Wastewater* will be changed to "latest edition." This revision will ensure that the most current version provides the regulatory framework, not an outdated version, as can occur if a specific edition is referenced without qualification.

Additionally, a punctuation error made in the 1993 Basin Plan amendment will be addressed. This draft change as detailed below will prevent the interpretation that numeric receiving water objectives for specific toxicants must be established. Also, it limits the prescription of bioassays to situations where appropriate.

Draft Strikeout Underline Changes:
In addition, effluent limits based upon ~~acute~~ bioassays of effluents will be prescribed~~.~~, ~~W~~where appropriate~~,~~. ~~a~~Additional numeric~~al~~ receiving water objectives for specific toxicants will be established as sufficient data become available~~,~~ and source control of toxic substances ~~will~~ may be ~~encouraged~~ required.

Draft Clean Copy:
In addition, effluent limits based upon bioassays of effluents will be prescribed, where appropriate. Additional numeric receiving water objectives for specific toxicants will be established as sufficient data become available, and source control of toxic substances may be required.

3.5.19 "Turbidity" Objective

No revisions proposed to the existing language.

3.6 Revisions to Tables 3-1 and 3-1a - "Specific Water Quality Objectives"

Table 3-1 footnote 5 currently contains the waterbody-specific temperature objectives for the Upper Trinity River. The information presented in this footnote will be reformatted as a stand-alone table (Table 3-1b), similar to the format used for the waterbody-specific Klamath River dissolved oxygen (DO) objective. This change will require renumbering of the remaining Table 3-1 footnotes.

The title, Waterbody-*Specific Objectives (WSOs) for Dissolved Oxygen in the Mainstem Klamath River*, will be added to Table 3-1a for clarity and to facilitate placement into the Table of Contents.

Table 3-1 Specific Water Quality Objectives for the North Coast Region, Table 3-1a Waterbody-Specific Objectives for Dissolved Oxygen (DO) in the Mainstem Klamath River, and Table 3-1b Waterbody-Specific Objectives for Temperature in the Upper Trinity River will be relocated to the end of the chapter to improve readability.

3.7 Deletion of Table 3-2 - "Inorganic, Organic, and Fluoride Concentrations Not to be Exceeded in Domestic or Municipal Supply"

The deletion of Table 3-2 is consistent with the revisions and updates made to the objective for chemical constituents for both surface waters and groundwaters. Fifty-one numeric objectives adopted to protect waters with the beneficial use municipal and domestic supply (MUN) are identified in Table 3-2 - *Inorganic, Organic and Fluoride Concentrations Not to Be Exceeded in Domestic or Municipal Water Supply.* The numeric objectives in Table 3-2 are based upon the MCLs that were specified in Title 22 of the California Code of Regulations at the time Table 3-2 was adopted or last revised. MCLs are established for drinking water protection only and are not necessarily protective of aquatic life or other beneficial uses. Updates that have been made to these regulations, such as additional constituents and changes to MCL values, have not been explicitly incorporated into the Basin Plan. In addition, only 27 of the 126 priority pollutants included in the NTR and CTR are included in this table of chemical constituents that affect waters with the beneficial use municipal and domestic supply.

The presence of the outdated and incomplete information contained in Table 3-2, *Inorganic, Organic, and Fluoride Concentrations Not to be Exceeded in Domestic or Municipal Supply*, of the Basin Plan results in confusion and inefficiencies affecting staff and the public's time and resources. To alleviate this problem, staff recommends updating the references, making them prospective and removing the outdated Table 3-2.

3.8 Revision to Water Quality Objectives for Groundwaters

The water quality objectives for groundwaters section contain four water quality objectives that apply to the protection of groundwater in the Region. Three of these objectives require minor revisions while a new narrative toxicity objective is proposed for the reasons detailed throughout this chapter. Additionally, the objectives will be rearranged and presented in alphabetical order for the user's convenience.

3.8.1 "Bacteria" Objective

A minor editorial change from the State Department of Health Services to the State Water Board Division of Drinking Water is the only proposed modification to the objective for bacteria. No substantive revisions to the bacteria objective are proposed as part of this amendment. Significant substantive revisions are required to appropriately update this objective. Such revisions have been postponed until an objective with statewide applicability is adopted by the State Water Board as part of their ongoing effort to update freshwater bacteria standards. Please see Section 3.5.5 above for further discussion.

3.8.2 Revisions to "Radioactivity" Objective

The current objective for radioactivity refers to groundwaters with the beneficial use municipal and domestic supply (MUN). To ensure that this objective appropriately applies to all beneficial uses of groundwaters, Regional Water Board staff proposes to alter the language to more broadly refer to beneficial uses, so as to encompass all beneficial uses of waters. Reference to Title 22 will be deleted from this objective. Additionally, staff recommends updating the references, making them prospective and removing the outdated values from the Basin Plan.

3.8.3 Revisions to "Tastes and Odors" Objective

Staff proposes to remove the language stating that State Department of Health Services and U.S. EPA numeric objectives are incorporated into waste discharge requirements and cleanup and abatement orders. To accomplish this, the proposal is to update the references, make the incorporation prospective and eliminate the second paragraph of the current objective.

3.9 Revisions to "Compliance with Water Quality Objectives" Section

The Compliance with Water Quality Objectives section of the Water Quality Objectives chapter of the Basin Plan (Chapter 3) has been revised and relocated to Chapter 4 Implementation Polices and Action Plans. Revisions are made to ensure the section is consistent with the State Water Board's *Policy for Compliance Schedules in National Pollutant Discharge Elimination System Permits,*[5] adopted in 2008, which upon adoption superseded the *Compliance with Water Quality Objectives* contained within Chapter 3 of the Basin Plan and *Schedules of Compliance* section presented in Chapter 4.

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[5] State Water Board Resolution 2008-0025.

4. Draft Revisions to Basin Plan Section 4 (Implementation Plans)

This chapter of the Staff Report presents a discussion of the revisions to Section 4 (Implementation Plans) proposed as part of this Basin Plan amendment. The following information describes the scope and rationale for the recommended revisions. The actual draft language is included in Appendices B and D (strikethrough/underline copy and clean copy, respectively). Additionally, this chapter generally describes the authorities which the Regional Water Board uses when implementing water quality objectives.

Both the 2007 and 2011 Triennial Reviews of the Basin Plan identified numerous issues relative to Section 4 (Implementation Plans) that warranted staff investigation. Staff initiated a Basin Plan amendment in 2010 that addressed two primary issues: First, the need to create a policy that articulates the process the Regional Water Board uses to translate narrative water quality objectives into numeric values, and second, the need to develop a comprehensive groundwater protection policy to address the discharge of waste to land. Due to the complexity of the issues associated with this task (and the existing structure of the Basin Plan), staff has adopted a two-phased approach to address these issues. This first phase focused on the effort necessary to complete the revisions to water quality objectives contained in Section 3 of the Basin Plan (Water Quality Objectives) and the addition of a Narrative Water Quality Objectives Translation Policy (Translation Policy).

Two different versions of the draft amendment for the first phase developed by Regional Water Board staff were released for public comment, the first in 2012 and the second in 2013. Both of these versions included a Translation Policy to clarify the existing process of implementing narrative water quality objectives in permits and other regulatory actions. The Translation Policy was an attempt to clarify how existing laws (Clean Water Act and Porter-Cologne Water Quality Control Act, California Water Code, etc.), regulations (California Code of Regulations, Health and Safety Code, etc.), plans and policies (Basin Plan, State Water Board Antidegradation Policy, Sources of Drinking Water Policy and Cleanup Policy, etc.) work together when translating narrative objectives into numeric values to be implemented in regulatory actions. However, public comments received indicated that attempting to develop such a policy created more confusion than clarity. Given public comments, staff now proposes to use an alternative approach to achieving the project goals. Specifically, staff proposes to simply add narration to both Sections 3 and 4 of the Basin Plan that describes the longstanding approach the Regional Water Board has taken to exercising its authorities derived from laws, regulations, plans and policies, when implementing water quality objectives.

Draft language has been added to Section 3 (Water Quality Objectives) to frame the context of what narrative and numeric water quality objectives are, how they are implemented to protect beneficial uses, and how specific policies are applied. Additionally, draft language was added to Section 4 (Implementation Plans) to briefly frame the main regulatory tools implemented to protect beneficial uses and to achieve compliance with water quality objectives.

These draft revisions are primarily adapted from language found in Basin Plans from other regional water board Basin Plans including those of the San Francisco Bay Region, Central Coast Region, Central Valley Region, and Lahontan Region. The recommended revisions to Section 4 (Implementation Plans) included as part of this amendment are presented below.

- Implementation of the chapter and section number system used in previous editorial amendments of the Basin Plan (Chapters 1 and 2).
- Rename Section 4 as *Implementation Policies and Action Plans*.
- Revision of page numbers to remove ".00" from each page, resulting in the format "4-x."
- Addition of the *Controllable Water Quality Factors* discussion relocated from the section 3 of the Basin Plan.
- Addition of paragraphs further describing *Control Action under State Board Authority*, *Control Action to be implemented by Other Agencies with Water Quality or Related Authority* and *Control Action under Regional Board Authority* which includes language removed from Section 3.
- Addition of sub-sections to describe the various types of control actions (permits/orders) issued by the Regional Water Board including *Water Quality Certifications*, *National Pollutant Discharge Elimination System (NPDES) Permits*, *Waste Discharge Requirements*, and *Waivers of Waste Discharge Requirements*.
- Addition of a new sub-section, *Prohibitions and Exceptions to Prohibitions* describing the Regional Water Board's authority to establish waste discharge prohibitions and exemptions.
- Addition of a new sub-section, *Monitoring and Reporting* generally describing the application of monitoring requirements within permits and orders.
- Relocation and revision to the sub-section, *Compliance with Water Quality Objectives*, which describes the application of NPDES permit limitations based on new or revised water quality objectives or prohibitions adopted by the Regional Water Board or State Water Board and includes the reference to the State Water Board's *Policy for Compliance Schedules in National Pollutant Discharge Elimination System Permits,*[1] which was adopted in 2008, and which upon adoption superseded the *Compliance with Water Quality Objectives* contained within Section 3 of the Basin Plan and *Schedules of Compliance* section presented in Section 4.
- Addition of a new sub-section, *Enforcement Actions,* which includes descriptions of the various tools available to the Regional Water Board to ensure compliance including *Notice to Comply, Notice of Violation, Cleanup* and *Abatement Order, Cease and Desist Order*, and *Administrative Civil Liability.*

[1] State Water Board Resolution No. 2008-0025.

Major portions of the Basin Plan are currently identified as "sections" within the text and Table of Contents of the Basin Plan. No numbering system is currently applied to lesser parts of these major portions. As part of this amendment, staff has proposed to replace the term "sections" with "chapters" to identify the major portions of the Basin Plan up through Section 3. These same revisions, however, will be accomplished in Section 4 as part of the second phase of this project. This is because the more substantial revision of Section 4 will be undertaken at that time.

The current page-numbering scheme of the Basin Plan was implemented to accommodate updating of hard copy Basin Plans on a page-by-page basis. The scheme utilizes numbering such as "4-9.00" and "4-10.00." This allows an updated page to easily be inserted between these pages as page "4-9.01," for example, without the need to replace additional pages unnecessarily. Updating hard copy Basin Plans in this manner has become an uncommon occurrence due to advances in technology and improved ways of providing updates of the Basin Plan to interested parties. Most commonly, complete sections of the Basin Plan are published in a portable document format (pdf) on the Regional Water Board website. As part of this amendment, staff proposes to replace this numbering scheme with a "4-x" format, but only for chapters up through Chapter 4 (Implementation Policies and Action Plans), currently called sections.

4.1 Summary

The draft proposed changes to Chapter 4 (Implementation Plans) are for the purpose of providing the necessary context by describing the regulatory tools by which the Regional Water Board achieves compliance with water quality objectives. In combination with the changes made to Chapter 3 (Water Quality Objectives), greater clarity is provided on the multiple layers of laws, regulations, plans and policies that are applicable and considered when determining numeric limits in Regional Water Board permits, orders or other regulatory actions. To determine such limits, it is first necessary to understand all such influencing factors, including site-specific technical factors.

The 2012 and 2013 amendment packages included a draft Translation Policy for the purpose of explaining how the applicable laws, regulations and policies are generally applied to determine numeric limits in Regional Water Board actions. As an alternative, the current amendment package simply elaborates on the existing laws, regulations, and policies to achieve the goal of clarity. The actual draft language is included in Appendices B and D (strikethrough/underline copy and clean copy, respectively).

5. Compliance with the California Environmental Quality Act

The Regional Water Board is the lead agency for evaluating the environmental impacts of Basin Plan amendments pursuant to the California Environmental Quality Act (CEQA). Although subject to CEQA requirements, the Regional Water Board basin planning process is certified by the Secretary for Resources as "functionally equivalent" to CEQA, and therefore exempt from the requirement for preparation of an environmental impact report or negative declaration and initial study[1]. The State Water Resources Control Board (State Water Board) has promulgated guidelines for exempt regulatory programs that describe the documents required for the adoption or approval of standards, rules, regulations or plans[2]. These documents must do the following:

1. Provide a brief description of the proposed activity.
   In this case, the proposed activity is the adoption of a Basin Plan amendment including:
   a) Addition of a Water Quality Objective for Groundwater Toxicity;
   b) Revisions to the Chemical Constituents Water Quality Objective for Groundwater and Surface Waters;
   c) Revision to the existing water quality objective for Dissolved Oxygen (DO) in surface waters; and
   d) Substantive editorial and organizational changes to Section 3 and Section 4 of the Basin Plan to improve clarity on implementation of water quality objectives and readability. The rationale to support the proposed Basin Plan amendment is fully described in Chapters 2, 3 and 4 of this Staff Report. A more detailed project description is provided in Section 5.1.

2. Provide a reasonable discussion of alternatives to the proposed activity.
   An alternatives analysis is provided in Section 5.3.

3. Provide an analysis of mitigation measures needed to minimize any potentially significant adverse environmental impacts of the proposed activity.
   Discussion is provided in Section 5.4.

Additionally, for actions by the Regional Water Board that adopt a rule or regulation requiring the installation of pollution control equipment, establish a performance standard or establish a treatment requirement, CEQA[3] and CEQA Guidelines[4] require an environmental analysis of the reasonably foreseeable methods by which compliance with that rule or regulation will be achieved. An SED satisfies this requirement if it contains the following components, some of which are a repetition of the list above:

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[1] Cal. Code Regs., tit. 14, § 15251 subd.(g).
[2] Cal. Code Regs., tit. 23, § 3777.
[3] Pub. Resources Code, § 21159 subd. (a).
[4] Cal. Code Regs., tit.14, § 15187 subd. (c).

1. An analysis of the environmental impacts resulting from implementation of the reasonably foreseeable methods of compliance. The reasonably foreseeable methods of compliance (hereinafter compliance measures) are the potential actions that responsible parties may employ to comply with the water quality objectives in the Basin Plan. This analysis is presented in Sections 5.4 and 5.5.
2. An analysis of the reasonably foreseeable feasible mitigation measures relating to the identified environmental impacts. This analysis is presented in Sections 5.4 and 5.5.
3. An analysis of reasonably foreseeable alternative means of compliance with the rule or regulation, which would avoid or eliminate any identified impacts. This analysis is presented in Section 5.6.

The environmental analysis must take into account a reasonable range of:[5]

- Technical factors (see Analysis of Compliance Measures, Associated Environmental Impacts, and Potential Mitigation Measures, Sections 5.4 and 5.5.);
- Population (see Environmental Setting and Land Use, Section 2.1);
- Geographic areas (see Environmental Setting and Land Use, Section 2.1);
- Specific sites (see Analysis of Compliance Measures, Associated Impacts, and Potential Mitigation Measures, Sections 5.4 and 5.5.); and
- Economic Consideration (see Chapter 6).

While the Board is required to consider of a "reasonable range" of the factors listed above, an examination of every site is not required, only consideration of a reasonably representative sample of sites. In meeting the requirements of CEQA section 21159, the regional board is not required to conduct a "project level analysis[6]." Rather, in most circumstances, a project level analysis will be performed by the responsible party or the agency with jurisdiction when an activity is conducted in conformance with the program evaluated here.

Consistent with the CEQA, this document does not engage in speculation or conjecture, but rather considers the project alternatives, the reasonably foreseeable environmental impacts of the reasonably foreseeable methods of compliance, and the mitigation measures which would be required to avoid, minimize, or mitigate the identified impacts. The adoption of the draft WQO Update Amendment does not result in any direct adverse effects on the environment. All potentially significant adverse effects are related to individual specific projects or permits and specific compliance measures which may be implemented in conformance with the draft amendment. The analysis provided uses specific circumstances as examples or illustration of how this draft WQO Update Amendment could be implemented, and thus affect the environment. However, this analysis does not constitute an absolute outcome or certainty in the determinations made in this Staff

[5] Cal. Code Regs., tit. 14, § 15187 subd.(d); Cal.Code Regs.,tit.23 § 3777; Pub. Resources Code, § 21159 subd. (c).
[6] Public Resources Code, § 21159 subd. (d).

Report. Therefore, this environmental analysis is set at a programmatic level and is more general in nature to cover the range of potential effects.

5.1 Description of the Project

The draft WQO Update Amendment includes a number of actions relative to updating water quality objectives for both surface waters and groundwaters in the North Coast Region. The four main components of the draft WQO Update Amendment are:

1) Develop a new narrative groundwater toxicity objective;
2) Update the chemical constituents objectives for surface waters and groundwaters;
3) Update the dissolved oxygen (DO) objectives for surface waters; and
4) Include substantive editorial revisions to improve clarity on the implementation of water quality objectives, readability and organization through non-substantive editorial changes.

Currently Regional Water Board staff use the authorities in the existing Basin Plan in combination with statewide policies such as the *Policy for Implementation of Toxic Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (State Implementation Plan or SIP); *Antidegradation Policy Resolution No. 68-16* (State Water Board Res No. 68-16); and *Policy on Cleanup and Abatement* Resolution No. 92-49 (State Water Board Res No. 92-49), and other established and relevant numeric water quality criteria when issuing permits, orders, or other regulatory actions. Since this process is complex and promotes confusion and contention, staff has included additional language to make more explicit the responsibilities and authorities of the Regional Water Board with respect to the establishment and implementation of water quality objectives.

The draft amendment is designed to update the existing aquatic life criteria to include protection against both acute and chronic effects of DO impairment. The draft amendment also addresses the problems associated with Table 3-1 of the Basin Plan in which waterbody-specific objectives (WSOs) for DO are assigned to individually named waterbodies in the Region. The problems this amendment will solve include: 1) a reliance on day time grab-sample data to define the daily minimum condition, and 2) an inconsistency in approach to the WSOs between waterbodies in the Klamath River Basin and those in the North Coastal Basin. The proposed solution to the problems associated with the WSOs for DO is to replace the WSOs with a natural conditions clause which requires that the natural pattern and range of ambient DO variability be maintained in those waterbodies which cannot, due to natural conditions, meet the aquatic life criteria.

The revisions proposed in the water quality objective Basin Plan Amendment project are presented below.

1) **Add a new narrative toxicity water quality objective for groundwater (Basin Plan Section 3)**
   a. A new narrative toxicity groundwater objective is intended to be more direct and transparent in regards to the protection of the beneficial uses of groundwater. Rather than solely relying on a footnote in the Basin Plan, the Antidegradation Policy (Res. No 68-16), the Policy for Cleanup and Abatement of Discharges (Res. No 92-49), and/or other existing authorities when establishing numeric thresholds necessary to protect beneficial uses which are used as a basis for calculating/developing effluent limits, cleanup or action levels, Regional Water Board staff can simply point to a toxicity objective for groundwater. The existing policies will still be adhered to; however, a groundwater toxicity objective is elegant in its simplicity.

2) **Update the water quality objectives for chemical constituents in surface water and groundwaters (Basin Plan Section 3)**
   a. Revision of the narrative chemical constituents objectives (surface water and groundwater) to clearly apply to the protection of all beneficial uses.
   b. Delete Table 3-2, *Inorganic, Organic, and Fluoride Concentrations Not to be Exceeded in Domestic or Municipal Supply*.
   c. Prospectively incorporate the Primary and Secondary MCLs listed in Title 22 of the California Code of Regulations, , as the minimum water quality objectives for chemical constituents to protect beneficial uses.
   d. Revise the narrative pesticides objective (surface waters) to clearly apply to the protection of all beneficial uses and remove the reference to Title 22.
   e. Revise the radioactivity objective (surface waters) to clearly apply to the protection of all beneficial uses and remove the reference to Title 22.

3) **Revise the water quality objective for dissolved oxygen in surface waters (Basin Plan Section 3)**
   a. Revision of the life cycle DO objectives based on USEPA (1986) and other scientific literature as described in Section V.1.3
   b. Elimination of the background DO objectives from Table 3-1 except for Humboldt Bay, Bodega Bay, and ocean waters.
   c. Inclusion of a "natural conditions" clause that allows for the calculation of background DO objectives based on 85% DO saturation during the dry season and 90% DO saturation during the wet season under natural stream temperatures in those waterbodies or reaches of waterbodies where natural conditions prevent the attainment of aquatic life DO objectives.
   d. Elimination of the 7.0 mg/L daily minimum for the *Spawning, Reproduction, and/or Early Development (SPWN)* beneficial use requirement as under protective.
   e. Expansion of the period of time in which the 9.0 mg/L daily minimum SPWN requirement is applied to include all early life stages prior to emergence.

SPWN applies from the time salmonid spawning begins until emergence, estimated in the North Coast Region generally to occur from September 15th to June 4th.

f. Addition of a 7-day average requirement based on the "no production impairment" for SPWN. This is a moving 7-day average of 11.0 mg/L DO in the water column based on seven consecutive daily averages.
g. Addition of daily minimum criteria of 9.0 mg/L to support SPWN; water column criteria that are 3 mg/L greater than the DO concentration required for *Cold Freshwater Habitat (COLD)* of 6.0 mg/L, to support the intragravel environment to protect eggs and pre-emergence life stages.
h. Addition of a 7-day average daily minimums ≥8.0 mg/L for COLD. This is a moving 7-day average of DO in the water column based on 7 consecutive daily minimums.
i. Addition of 6.0 mg/L as a 7-day moving average of the daily minimum for *Warm Freshwater Habitat (WARM)*.
j. Retention of the existing 5.0 mg/L DO objective for *Inland Saline Water Habitat (SAL)* and *Marine Habitat (MAR)* and 6.0 mg/L DO objective for Bodega Bay and Humboldt Bay as adequate protection of these beneficial uses and locations.
k. Adoption of a narrative DO objective for the protection of *estuarine habitat (EST)*: "The dissolved oxygen content of enclosed bays and estuaries shall not be depressed to levels that adversely affect beneficial uses as a result of controllable water quality factors."

4) Edit and organize Basin Plan Sections 3 and 4

a. Addition of explanatory language in Section 3 generally describing narrative and numeric water quality objectives.
b. Addition of a footnote in Section 3 clarifying that the terms "designated use" and "water quality criteria" are based in federal law.
c. Addition of a footnote in Section 3 clarifying that "beneficial use" and "water quality objectives" are terms derived from state law.
d. Relocation of the existing text in Section 3 describing controllable factors to its own section in Chapter 4. In addition, the phrase "human caused" will be substituted for "man caused."
e. Deletion of outdated or redundant text in Section 3 such as the reference to expired waivers, the description of classes of water (which is presented in Chapter 2 – Beneficial Uses) and the superseding of water quality objectives contained in earlier editions of the Basin Plan.
f. Removal of references in Section 3 to appendices no longer proposed for inclusion in the Basin Plan.
g. Addition of new sub-section in Section 3describing terminology for water quality standards.

h. Addition of new sub-section in Section 3 describing terminology for water quality objectives and effluent limitations.
i. Other minor editorial changes, such as capitalization, punctuation, grammar, and other minor revisions to improve clarity.
j. Implementation of the chapter and section number system used in previous editorial amendments of the Basin Plan (Chapters 1 and 2).
k. Rename Section 4 as *Implementation Policies and Action Plans*.
l. Revision of page numbers to remove ".00" from each page, resulting in the format "3-x."
m. Addition of the *Controllable Water Quality Factors* discussion relocated from the Section 3 to Section 4 of the Basin Plan.
n. Addition of paragraphs in Section 4 further describing *Control Action under State Board Authority*, *Control Action to be implemented by Other Agencies with Water Quality or Related Authority* and *Control Action under Regional Board Authority* which includes language removed from section 3.
o. Addition of sub-sections in Section 4 to describe the various types of control actions (permits/orders) issued by the Regional Water Board including *Water Quality Certifications*, *National Pollutant Discharge Elimination System (NPDES) Permits*, *Waste Discharge Requirements*, and *Waivers of Waste Discharge Requirements*.
p. Addition of a new sub-section in Section 4, *Prohibitions and Exceptions to Prohibitions* describing the Regional Water Board's authority to establish waste discharge prohibitions and exemptions.
q. Addition of a new sub-section in Section 4, *Monitoring and Reporting* generally describing the application of monitoring requirements within permits and orders.
r. Relocation and revision to the sub-section in Section 4, *Compliance with Water Quality Objectives*, which describes the application of NPDES permit limitations based on new or revised water quality objectives or prohibitions adopted by the Regional Water Board or State Water Board and includes the reference to the State Water Board's *Policy for Compliance Schedules in National Pollutant Discharge Elimination System Permits,*[7] which was adopted in 2008, and which upon adoption superseded the *Compliance with Water Quality Objectives* contained within Section 3 of the Basin Plan and *Schedules of Compliance* section presented in Section 4.
s. Addition of language in Section 4 in the *Compliance with Water Quality Objectives* subsection regarding the Region's assessment of compliance in waterbodies where the background concentrations of a constituent exceed the water quality objectives.
t. Addition of a new sub-section in Section 4, *Enforcement Actions,* which includes descriptions of the various tools available to the Regional Water

[7] State Water Board Resolution No. 2008-0025.

Board to ensure compliance including *Notice to Comply, Notice of Violation, Cleanup* and *Abatement Order, Cease and Desist Order*, and *Administrative Civil Liability.*

5.2 CEQA Scoping

The Regional Water Board solicited comments from interested persons and governmental agencies regarding the scope and content of the environmental information to be included in the SED. On July 8, 2010, the Regional Water Board held a CEQA Scoping Meeting following circulation of a Public Notice.

The purpose of the meeting was to explain the project and provide related information to resource agency personnel and the interested public and to invite them to submit written comments concerning the range of actions, alternatives to the draft Basin Plan amendment, mitigation measures, and significant effects that should be analyzed in the SED. Staff provided relevant information including a presentation on the Basin Plan amendment process, the draft Water Quality Update Amendment, and the CEQA process. Informational handouts included the scoping notice and fact sheet, and a copy of the Power Point presentation for the Scoping Meeting and checklist based on appendix G of the CEQA guidelines. The scoping period ended on July 22, 2010. Staff did not receive any comments during the comment period for scoping. While the 2010 scoping meeting did include an additional phase of work, as described in section 1.2.1 of this Staff Report, the general scope and goals of the project has remained the same.

The draft revisions to the DO objectives were scoped separately from the remainder of the draft amendment. Two CEQA Scoping Meetings were held in the fall of 2008, one in Santa Rosa and one in Weaverville. A Scoping Document was presented at the meeting and public comments solicited both verbally and in writing. In the spring of 2009, a draft Staff Report was submitted for scientific peer review. The proposed approach was used to calculate a waterbody-specific objective (WSO) for DO in the mainstem Klamath River. The Regional Water Board adopted the WSO in March 2010. It was approved by the State Water Board, Office of Administrative Law, and USEPA, becoming effective in December 2010.

5.3 Analysis of Reasonable Alternatives to the Proposed Activity

Regional Water Board staff has identified four approaches (or alternatives) to fulfill the project objectives (i.e., update the water objectives for chemical constituents and DO, addition of a groundwater toxicity objective and provide clarity for the translation of narrative objectives into numeric thresholds to be implemented in Regional Water Board orders). The purpose of this analysis is to determine if there is an alternative that would feasibly attain the basic project objectives of the rule or regulation, but would lessen, avoid, or eliminate any identified adverse environmental impacts.

The alternatives are compared on the basis of their ability to protect water quality and beneficial uses (i.e., their likelihood of success) and whether the approach is feasible, flexible and equitable. The four alternatives are summarized as follows:

1. No Action;
2. Establish numeric water quality objectives for all constituents of concern;
3. Establish narrative water quality objectives for all constituents of concern and a narrative translation policy to determine appropriate numeric thresholds to implement the narrative objectives; and,
4. Proposed project.

5.3.1 Alternative 1, No Action - No Change in Basin Plan Language or in Program Implementation

Under the "No Action" alternative, no amendment to the Basin Plan would occur and staff would continue to implement existing Regional and State Water Board programs, as in the past. Under this alternative, numeric water quality objectives for DO and numerous chemical constituents would remain outdated. Implementation of Porter-Cologne, State Water Board plans and policies, and the Regional Water Board's plans and policies would continue in the same manner as is now the case.

It should be noted that environmental impacts associated with the no project alternative are likely to be the same as the proposed project alternative. The proposed project alternative is essentially designed to make explicit in the Basin Plan the process by which the Regional Water Board already implements its authority under Porter-Cologne, including its obligations under the State Water Board's plans and policies and the Regional Water Board's plans and policies.

With respect to DO, the "no action" alternative is to retain the DO objectives as written in the Basin Plan without update or revision. The No Action Alternative would leave Table 3-1 unchanged, including background DO objectives developed based on grab sample data from the 1950s and 1960s. As an example, the background DO objectives would be retained for the Laguna de Santa Rosa, even given the results of water quality studies for DO demonstrating that natural conditions (in the absence of anthropogenic effects) result in periodic DO concentrations less than the given objectives. The life cycle DO objectives would continue to protect against acute effects. However, they would provide no protection against the chronic effects of DO stress, including reduced reproductive success, reduced growth, and increased susceptibility to disease. The background DO objectives would continue to apply instead of life cycle DO objectives in those waterbodies listed in Table 3-1.

Pros:

- Allows re-direction of Basin Planning staff to begin/continue work on the next issue on Triennial Review Priority List.

Cons:

- The numeric chemical constituent objectives specified in the basin plan would often conflict with the numeric thresholds identified as appropriate through application of other more stringent objectives and policies.
- Does not address the scientific advances made in understanding the natural patterns and range of DO or the acute and chronic effects on beneficial uses.

5.3.2 Alternative 2, Adopt a Basin Plan Amendment that: 1) Updates the Chemical Constituents Objectives with the Current Numeric Values Title 22; 2) Adds New Numeric Groundwater Toxicity Objectives; and 3) Waterbody-Specific Objectives for DO

Under this alternative, the Basin Plan would be amended to include specific numeric objectives for DO, each chemical constituent, and each toxicant of concern. Tables 3-1 and 3-2 of the Basin Plan would be expanded to include all current primary and secondary MCL values and create a new table relevant to the toxicity of chemicals and watershed site - specific objectives (WSO) for DO. Each beneficial use would have relevant acute and chronic toxicity water quality objectives to be implemented as appropriate in Regional Water Board Orders.

Staff is not recommending this alternative because it would establish in the Basin Plan objectives which would soon become outdated, as chemical constituents and toxicity-based thresholds are modified as part of other state efforts and advances reported in the scientific literature. Otherwise keeping the Basin Plan up to date for chemical constituents would require significant staff time in amending the plan on a frequent basis. Additionally, it does not make wise use of resources which are already applied in developing MCLs and Public Health Goals (PHGs) through other state-funded efforts.

Pros:

- Broadly supports water quality protection.
- Provides waterbody-specific objectives and reduces the need to have a natural conditions clause.

Cons:

- Would require significant staff time to keep the Basin Plan updated with changes to MCLs and relevant toxicological information.
- Does not address the numeric values of chemicals constituents and toxic substances that are not specified in the Basin Plan.
- Developing SSOs for DO in each watershed would require a significant amount of state resources and would not likely be completed for decades.

5.3.3 Alternative 3, Adopt Basin Plan Amendment that Includes: 1) A Narrative Objectives for Groundwater Toxicity; 2) Updates the Chemical Constituents Objectives with the Current Numeric Values Title 22; 3) Updates DO Objectives; and 4) Includes a Narrative Water Quality Objective Translation Policy

Under this alternative, the Basin Plan would be amended to include narrative water quality objectives for DO, chemical constituents, and toxicity. In addition, the Basin Plan would be revised to include a narrative translation policy describing the process by which appropriate numeric thresholds are identified to implement the narrative objectives.

Pros:

- The incorporation of a narrative translation policy would improve the regulatory clarity and transparency, as compared to the no action alternative.

Cons:

- Creates another policy on top of the existing laws and regulations that would still need to be applied on case by case basis.
- Does not include specific numeric values for every constituent of concern and their potential acute or chronic effect thresholds on each beneficial use.

5.3.4 Alternative 4, Draft Alternative: Adopt Basin Plan Amendment that Includes: 1) A Narrative Objectives for Groundwater Toxicity; 2) Prospectively Incorporates Current Numeric Values Listed in Title 22 as the Chemical Constituents Objective; 3) Revises the Aquatic Life DO Objectives; and 4) Includes Substantive Edits Clarifying the Implementation of Water Quality Objectives

Staff recommends adoption of this proposed alternative as a Basin Plan amendment because it provides the most regulatory clarity and transparency while also ensuring that objectives (and the numeric thresholds identified to implement them) are up-to-date and relevant. This alternative is a balance between discretion and precision, and provides flexibility, clarity and transparency.

This alternative includes the revision of the Basin Plan's DO objectives, as follows:

- Revision of the aquatic life DO objectives based on USEPA (1986) and other scientific literature as described in Section V.1.3;
- Elimination of the background DO objectives from Table 3-1 except for Humboldt Bay, Bodega Bay, and ocean waters.
- Inclusion of a "natural conditions" clause that allows for the calculation of background DO objectives based on 85% DO saturation during the dry season and 90% DO saturation during the wet season (based on natural stream temperatures) in those waterbodies or reaches of waterbodies where natural conditions prevent the attainment of aquatic life DO objectives.

Pros:

- Updates the minimum objectives for chemical constituents.

- Saves staff basin planning resources by prospectively incorporating MCLs.
- Clearly establishes a water quality objective related to groundwater toxicity.
- Makes clear and transparent the process used to implement water quality objectives in Regional Water Board orders.
- Reduces the risk of erroneous listing of DO on the 303 (d) list due to outdated water quality objectives.

Cons:
- Does not include specific numeric values for every constituent of concern and their potential acute or chronic effect thresholds on each beneficial use.

5.4 Analysis of Compliance Measures, Potential Environmental Impacts, and Possible Mitigation Measures

What follows is an analysis of potential environmental impacts associated with the wide range of compliance measures which could potentially be used to comply with the proposed alternative, including updated chemical constituents objectives, groundwater toxicity objective, and updated DO objectives. The specific compliance measures and pollution controls necessary to comply with the proposed alternative will depend on a number of site-specific conditions and factors. The following examples are not meant to be exhaustive of the suitable suite of compliance measures, but rather provide a representative sample with the widest range to accommodate as many compliance scenarios as possible. The analysis addresses compliance measures to address chemical constituent and toxicity control (Section 5.4.1) separately from those to address DO compliance (Section 5.4.2). The potential environmental impacts associated with the identified compliance measures are evaluated together (Section 5.4.3).

<u>General Compliance Measures</u>

In addition to many of the specific compliance measures for soil and groundwater cleanup, wastewater treatment, and various DO compliance measures, the general compliance measures listed below are often interchangeable as mitigation measures for potentially adverse environmental impacts associated with specific project activities. For instance, in one case a health and safety plan may be a required element of a groundwater cleanup action. On the other hand, a health and safety plan could be a mitigation measure to address potential hazards associated with a waste water treatment plant operation or upgrade. Examples include:

- Air Quality Control Plans – Several soil and ground water remediation technologies can cause a release of particulate matter, emission, and gases that can produce chronic or acute effects. Often these technologies are regulated via the local air quality management district. Plans should be developed in accordance with local provisions, standards and appropriate avoidance, minimization, and mitigation measures.
- Monitoring Well Installation and Sampling – Groundwater monitoring well installation is a common practice to assess the extent of constituents of concern and

the effectiveness of specific treatment and/or remedial actions. Depending on the circumstance, the drilling and construction of a groundwater well for the purpose of gathering soil and groundwater data to characterize site conditions can be considered a compliance measure and mitigation measure.

- Onsite Storage Areas – Remediation and treatment facilities often require areas to store equipment and materials. Such facilities are often enclosed and/or locked for health and safety purposes.
- Traffic Control Plans – Subsurface contamination can migrate offsite encountering city streets and highways. Investigations and remedial actions often require traffic control plans to conduct investigation along or adjacent to city or state right-of-way.
- Health and Safety Plans – Project-specific health and safety plans that identify and address physical, chemical and biological hazards at site locations. Plans include emergency access, incident procedures, site safety officer points of contact, safety zones, level of personal protective equipment required to access sites, and location and route to nearest hospital facilities.
- Monitoring and Reporting **-** Public Resources Code, section 21081.6 and California Code of Regulations, title 14, section 15097requires a Mitigation Monitoring and Reporting Program (MMRP) to ensure that mitigation measures identified in an EIR or negative declaration are implemented to avoid significant environmental effects. The MMRP must be adaptable according to the context, in this case, a programmatic policy with a broad range of implementation actions. As explained in the Staff Report and findings below, projects that might be undertaken as a result of the Basin Plan Amendment would be subject to a project-level CEQA review conducted by the Regional Water Board or by another lead agency, which would entail project-specific identification and mitigation of any significant environmental effects. These projects would be subject to a project-specific MMRP. The Basin Plan Amendment does include monitoring and reporting elements appropriate for its programmatic scope, and the implementation of mitigation measures can be tracked by these mechanisms. The most appropriate reporting mechanism is through the program-specific requirements. Monitoring the implementation of mitigation measures is most fitting in a project specific program of implementation. This includes specific projects both within and outside of the Regional Water Boards authority. While monitoring is listed as a general compliance measure and a potential mitigation measure for many of the potential impacts listed below it is most accurate to describe monitoring as a means of evaluating the effectives of mitigation measures allowing feedback for adaptive management and minimization of adverse effects.

5.4.1 Analysis of Compliance Measures to Address Water Quality Objectives for Chemical Constituents and Toxicity in Surface Waters and Groundwaters

<u>In-Situ Biological Remediation Compliance Measures</u>

- Bioventing – The injection of air into unsaturated soils to increase oxygen and stimulate existing soil microorganisms promoting biodegradation.

- Bioreactor landfills – The recirculation of leachate in aerobic or anaerobic or hybrid systems to accelerate the degradation of solid waste.
- Enhanced Biodegradation – In-situ methods of soil and/or groundwater remediation using microorganisms to degrade organic contaminants in soil, groundwater sludge, and solids. In-situ methods include drilling borings or wells for injection and treatment.
- Phytoremediation – The use of plants to aide in the treatment and remediation of contaminated soil and groundwater. Plants can enhance the rhizoshpere (microbes in the soil), provide hydraulic controls, promote photo-degradation (the metabolism of contaminates with plant tissues), and phyto-volitization (plants uptake contaminated water and release breakdown products through their leaves.
- Natural Attenuation – Relies on the natural process to decrease or "attenuate" concentrations in soil and ground water. Usually involves site modeling to project the attenuation timeframe and continued monitoring to verify decreasing concentrations.

<u>In-Situ Physical/Chemical Remediation Compliance Measures</u>

- Chemical Oxidation - Chemical oxidation uses chemicals called "oxidants" to help change harmful contaminants into less toxic ones. When oxidants are added to contaminated soil and groundwater, a chemical reaction occurs that destroys contaminants and produces harmless byproducts. To treat soil and groundwater in situ, the oxidants are typically injected underground by pumping them into wells. The five major oxidants used for ISCO are permanganate, persulfate, hydrogen peroxide, ozone and ultraviolet (UV) radiation.
- Electrokinetic Separation - In-situ method used to separate heavy metals, radionuclides, and organic contaminant from saturated or unsatured soils, sludges, sediments and groundwater. Involves the use of electrodes and low voltage direct currents to transport ions and ion complexes to migrate and can be trapped/removed by electroplating, precipitation, pumping, or complexing with ion exchange resins.
- Fracturing – Environmental fracturing are techniques used that enhance or create openings in bedrock or soils with low porosity to help remediation action work more effectively. Fracturing methods can be conducted hydraulically using water and/or slurries or pneumatically using air or gas injections.
- Soil Flushing – Involves the use of a solution to promote the mobilization to remove contaminants from the soils. The solution can be injected or infiltrated and is usually captured for disposal or recirculated. Flushing solutions can be acidic, basic, chelating or complexing agents, cosolvents or surfactants. Once the solution is activated the solution and or contaminated groundwater can be captured and treated as appropriate.
- Soil Vapor Extraction – SVE can remove contaminant vapors for treatment above ground. Typically used with air sparging wells to promote the volization and migration of vapors to be captured by applying a vacuum to soil vapor extraction wells which are plumbed to a system treat the vapors and gases.
- Air Sparging - The injection of air through sparge wells to promote degradation of

organic contaminants. Volatilize organic chemicals to gases for extraction and treatment.

- Air Stripping - Air stripping uses either and air stripper or aeration tank to force air through contaminated water and evaporate VOCs. The most common type of air stripper is a packed-column air stripper, which is a tall tank filled with pieces of plastic, steel or ceramic packing material.
- Bioslurping – A combination of dewatering and vacuum to simultaneously recover free product and bioremediate the vadoze zone. It is used to improve free-product recovery and minimize the capture of contaminated groundwater.
- Directional Wells – Drilling techniques are used to position wells horizontally or at an angle to reach contaminants that are not accessible by direct vertical drilling. These wells can be used for monitoring or treatment purposes.
- Dual Phase Extraction – DPE or multi-phase extraction combines numerous combinations of technologies to address, free-product, contaminated groundwater and/or hydrocarbon vapors. Extracted liquids and vapors are treated and collected for disposal.
- Permeable Reactive Barriers / Treatment Walls – A wall created below ground out of a reactive material that will either trap contaminants or treat them as water flows through. Used a variety of reactive agents such as iron to chemicals treat groundwater plumes as they migrate.
- Thermal Treatment - The use of heat to volatilize organic chemicals to gases for extraction and treatment. Common methods include electrical resistance heating, steam enhanced extraction, and thermal conduction heating.
- Treatment Wells - Groundwater circulation wells provide a technique for remediation by creating a three-dimensional circulation patter of the groundwater. Groundwater is draw through and pumped through multiple screen sections promoting circulation of volitization of contaminants. Groundwater injection wells provide a conduit for a number of remedial technologies used to treat contamination.

<u>Ex-Situ Biological Remediation Compliance Measures</u>

- Biopiles - Ex-situ methods of soil remediation using micro-organisms to degrade organic contaminants in soil, sludge, and solids. Ex-situ methods include pumping and treating groundwater or excavating soil and placing in stockpiles or treatment cells.
- Composting – Contaminated soils is mixed with bulking agents and organic amendments such as wood chips, hay, manure and vegetable wastes to stimulate microbial activity to promote biodegradation.
- Land Farming – Contaminated soil, sediment or sludge is excavated and applied to a containment unit (lined and/or berm) and periodically tilled or overturned to aerate waste.
- Slurry Phase – An aqueous slurry is created to keep solids suspended and microorganisms in contact with contaminated soils.
- Bioreactors – Contaminants in extracted groundwater are put into contact with microorganisms in attached or suspend growth biological reactors. Bioreactors

degrade contaminates in water and are often a several year process. Also, used in conjunction with activated carbon.

- Constructed Wetlands – The principal components of wetlands including organic soils, microbial flora and fauna, algae and vascular plants are used to biodegrade contaminants through ion exchange, adsorption, and microbial oxidation. Most commonly used in wastewater treatment applications.

Ex-Situ Physical/Chemical Remediation Compliance Measures

- Chemical Reduction – In situ chemical reduction, or "ISCR," uses chemicals called "reducing agents" to help change contaminants into less toxic or less mobile forms. Common reducing agents include zero valent metals, which are metals in their pure form. The most common metal used in ISCR is zero valent iron (ZVI), which must be ground up into small granules for use in ISCR. Other common reducing agents include polysulfides, sodium dithionite, ferrous iron, and bimetallic materials, which are made up of two different metals. The most common bimetallic material used in ISCR is iron coated with a thin layer of palladium or silver.
- De-Chlorination Injection/Reductive Treatment – In-situ and ex-situ methods of soil and/or groundwater remediation for contaminants such as such as heavy metals. The use of reductants to induce chemical reactions either converting the contaminants to a non-toxic form and/or resulting in the stabilization or migration of contaminants to be contained or extracted.
- Dehalogenation - Used to treat contaminated soil by heating and adding reagents to achieve decomposition or partial volitization. These methods have been used successfully to treat SVOCs, pesticides and PCBs.
- Separation/Soil washing - Contaminates sorbed onto fine soil particles are separated from bulk soil in a water-based system. Wash water may then be augmented or adjusted to reduce pollutants and adjust pH levels. The soils and water are usually separated into fractions using gravity settling.
- Activated Carbon Treatment - Activated carbon treatment generally consists of one or more columns, tanks or drums filled with granular activated carbon (GAC). Contaminated water or vapors are usually pumped through a column from the top down, but upward flow is possible. As the contaminated water or air flows through the GAC, the contaminants sorb to the outer and inner surfaces of the granules.
- Advanced Oxidation Process/Chemical Oxidation Injection - Chemical oxidation uses chemicals called "oxidants" to help change harmful contaminants into less toxic ones. When oxidants are added to contaminated soil and groundwater, a chemical reaction occurs that destroys contaminants and produces harmless byproducts. To treat soil and groundwater in situ, the oxidants are typically injected underground by pumping them into wells. The five major oxidants used for ISCO are permanganate, persulfate, hydrogen peroxide, ozone and ultraviolet (UV) radiation.
- Aeration/Air Sparging - Ex-situ methods of soil remediation include excavating contaminated soil and allowing contaminates to degrade in a stockpile or waste treatment cell. Additionally, ponds or tanks with air injections, fountains or

paddlewheels can be used to aerate and treat contaminated groundwater.

- Air-Stripping Tower – Volatilize organic chemicals to gases for extraction and treatment. Air stripping uses either and air stripper or aeration tank to force air through contaminated water and evaporate VOCs. The most common type of air stripper is a packed-column air stripper, which is a tall tank filled with pieces of plastic, steel or ceramic packing material.
- Excavation/Dredging – Removal of contamination sources and/or contaminated soils, muds and slurries either for onsite storage and treatment or offsite treatment and disposal.
- Groundwater Pumping/Extraction – Extraction wells are often installed and used to remove groundwater or gases and/or vapors resulting from subsurface contamination. Various types of drill rigs are used to bore into the subsurface target area where an extraction well can be constructed for the purposed of removing contaminated soil and water.
- Ion Exchange/Electrodialysis –The use of materials such as zerovalent iron, or solvent-impregnated resins, and/or membrane technology to remove metals, other inorganic chemicals, and radionuclides from contaminated water. Advanced membrane technology use ion-exchange membranes to desalinate water. This results in a desalinated stream and high concentrated salt brine stream. Typically used in a wastewater treatment train, after coagulation/flocculation and clarifiers.
- Lime Softening – Often used to reduce the hardness of water and enhance the clarification prior to filtration. A USEPA best achievable technology for arsenic, barium, beryllium, chromium, copper, fluoride, lead mercury, cadmium, nickel, and radionuclides.
- Precipitation/Coagulation/Flocculation/Sedimentation – Precipitation is often used to remove metals prior to other treatment process. Coagulants and flocculation are used to increase particle size through aggregation leading to sedimentation or flocculant settling.
- Reverse Osmosis – The use of a semipermeable membrane and pressure to remove contaminants from water through a process of ion exclusion, which concentrates rejected ions into a brine or high strength waste stream.

<u>Ex-Situ Thermal Remediation Compliance Measures</u>

- Hot Gas – The process involves raising the temperature of the contaminated equipment or materials to 500 °F for a specified period of time. Gases from the influent are treated in an afterburner system to destroy all volatilized contaminants. This method reduces stockpiled wastes, but required subsequent disposal of hazardous materials.
- Incineration – This process involves high temperatures ranging from 1,450 °F to 1,600 °F to volatilize and combust organics in hazardous wastes. Off gases usually require treatment. The most common types of incinerators include the circulating bed combustor, fluidized bed, infrared combustion, and rotary kilns.

- Pyrolysis – The chemical decomposition induced by organic material by heat in the absence or lack of oxygen. Used to transform hazardous organic materials into gaseous components, small amounts of liquid and a solid residue.
- Thermal Desorption – Wastes are heated to volatilize water and organic contaminants are volatilized.

Contamination Containment Compliance Measures

- Capping – Involves placing a cover (e.g., vegetation, clay, geomembrane, concrete or asphalt) over contamination to isolate contamination to prevent migration.
- Enhanced Capping/Evapotranspiration Covers –Like other caps over contaminated material; however, these are designed with specific soils and vegetation to promote capture and evaporation and transpiration through plants to help keep water from soaking into contaminated materials.
- Physical Barriers – Also known as slurry walls are used to contain soil and groundwater and divert contaminated flow from receptors like drinking water wells. These walls are tools to permanently control seepage and often used in conjunction with caps. Most slurry walls are constructed from soil, bentonite, geomembranes, and cement.
- Deep Well Injection – A method of drilling boreholes to the lower drinking water producing aquifer and backfilling them in a manner that prevents the vertical migration of contaminants. Often done with conductor casings and well packers to reduce the likelihood of cross contamination.

Wastewater Disinfection Compliance Measures

- Chlorine – A widely used disinfectant used to destroy target organisms (bacteria, protozoa, viruses, etc.) by oxidizing cellular material.
- Ozone – O_3 or Ozone gas is an unstable molecule used to disinfect water. A very strong oxidant which can be more effective than chlorine at removing harmful target organisms.
- Ultraviolet – Ultraviolet or US systems transfers electromagnetic energy from a mercury lamp to an organism's genetic material. UV radiation penetrated the cell wall and destroys its ability to reproduce.

Decentralized Systems Technology

- Aerobic Treatment – For locations not suitable for traditional septic systems (anaerobic) these systems can provide more suitable and higher level of treatment. Oxygen is transferred to the waste stream by diffused air, sparged turbine, or surface entrainment devices.
- Control Panels – Sensors and controls that ensure proper operation of systems. Often fitted with alarms, telemetry, current sensing, and programmable controls these measures are sometimes need to ensure proper function of high risk or problematic systems.
- Filters – Various types of filters using mechanical screening, media filters like sand,

textiles, peat, plastics, or even crushed glass can be used to increase surface area for biological process to take place and trap and treat the influent wastewater.

- Intermittent Sand Filters – Filter bends of graded granular material used to treat wastewater through intermittent dosing. Effluent percolates through the media and is transported through pluming for either further treatment or disposal.
- Low Pressure Pipe Systems – In location that are not ideal for traditional septic systems low pressure dosing systems have proven to be adequate alternatives. Level controls and/or timers are used for specific pumping sequences to appropriately dose the leach field or disposal area with treated wastewater.
- Mound Systems – For shallow groundwater or systems with unsuitable soils mounds can be constructed to overcome local site constraints. Usually pressures dosed sand filter mound systems are constructed above grade to enhance the treatment of native soils.
- Septic Systems – An onsite wastewater treatment system that usually includes gravity feed to an engineered below ground tank consisting of single of multiple chambers. Septic tanks have connecting piping to a leach field for additional treatment and disposal of wastewater. Septic systems can serve single or multiple households with the primary limiting factor being land availability and local soil conditions.

<u>Wastewater Treatment Compliance Measures</u>

- Aerated, Partial Mix Lagoons - Wastewater treatment methods include using ponds which circulate contaminated water via pumps, fountains, paddlewheels, jets, or subsurface compressed air bubbles. These ponds are effective at removing biological oxygen demand (BOD) and total suspended solids (TSS) in wastewater influent as a component of a multi-part treatment train.
- Advanced Ecologically Engineered System – Emerging technology that uses a series of tanks engineered in conjunctions with plants and microorganisms to mimic a natural wetland system. The treatment processes involve clarification, adsorption, nitrification, denitrification, volatilization and anaerobic decomposition.
- Anaerobic Lagoons – Deep ponds or impoundments that do not circulate or aerate wastewater and are used as a pretreatment method of industrial and municipal waste streams. Anaerobic lagoons are typically used to address high organic loads as part of a treatment train.
- Ammonia Stripping – The addition of lime or caustic to raise the pH of the wastewater until ammonium hydroxide ions are convert to ammonia gas which is the captured and treated by either cross-flow or countercurrent stripping towers.
- Ballasted Flocculation – High rate flocculation using additives to improve the settling of suspended solids. Used to enhance primary clarification or enhanced secondary clarification.
- Chemical Precipitation – Used for the removal of metal, inorganics, suspended solids, fats oils, greases and other organic substances (such as organophosphates) from wastewater. Through the use of polymers ion exchange is facilitated in wastewater. Dissolved compounds can then be removed by “softening” through the addition of line

and ferrous sulfate. Once metals are rendered insoluble they precipitate and settle from the wastewater, while fats oils and greases float and are skimmed off.

- Dechlorination – The process of removing residual chlorine form treated wastewater. Sulfur dioxide, carbon adsorption, sodium bisulfite, sodium metabisulfite, and/or hydrogen peroxide are commonly used to minimize potentially toxic disinfection byproducts in effluent.
- Denitrifying Filters – The use of media filters, flow designs, a carbon source and microorganisms to remove nitrate from the wastewater.
- Electrodialysis– An advanced membrane technology that uses ion-exchange membranes to desalinate water. This results in a desalinated stream and high concentrated salt brine stream. Typically used in a wastewater treatment train, after coagulation/flocculation and clarifiers.
- Fixation/chemical reduction - In-situ and ex-situ methods of soil and/or groundwater remediation for contaminants such as such as heavy metals. The use of reductants to induce chemical reactions either converting the contaminants to a non-toxic form and/or resulting in the stabilization or migration of contaminants to be contained or extracted.
- Facultative Lagoons – Waste stabilization ponds that are stratified with aerobic and anaerobic layers. These lagoons/ponds can be flow controlled and seasonally adjusted to treat raw, screened or primary settled wastewater.
- Free Water Surface Wetlands - Wetland systems where surface water is exposed to the atmosphere. Treated effluent flows through a constructed vegetated soil surface for advanced wastewater treatment or tertiary polishing. Oxidation and adsorption of total suspended solids, metals and complex organics can occur and be adsorbed by soils, plants and consumed by microorganisms within the wetland.
- Granular Activated Carbon Absorption & Regeneration - Activated carbon treatment generally consists of one or more columns, tanks or drums filled with granular activated carbon (GAC). Wastewater is usually pumped through a column from the top down, but upward flow is possible. As the contaminated water or air flows through the GAC, the contaminants sorb to the outer and inner surfaces of the granules. Generally found to be effective in treating soluble organic and inorganic compounds.
- Green Sand Filtration – Commonly known as New Jersey greensand, or glauconite, is used as a media to filter water to remove iron and manganese from drinking water.
- Ion Exchange/Electrodialysis –The use of materials such as zerovalent iron, or solvent-impregnated resins, and/or membrane technology to remove metals, other inorganic chemicals, and radionuclides from contaminated water. Advanced membrane technology use ion-exchange membranes to desalinate water. This results in a desalinated stream and high concentrated salt brine stream. Typically used in a waste water treatment train, after coagulation/flocculation and clarifiers.
- Membrane Bioreactors – Commonly used for secondary treatment of wastewater with the use of microorganisms. A microfiltration membrane is used in place of secondary

clarifiers and sand filters. Typically used on small systems or industrial or commercial applications.

- Oxidation Ditches – A modified activated sludge biological treatment process using long solid retention times using a single or multiple ditches sometimes in combination with aerators to provide additional secondary treatment.
- Package Plants – Pre-manufactured treatment facilities use to treat small communities or individual properties with typical flows between 0002 MGD and 0.5 MGD. Common types of plants include extended aeration plans, sequence batch reactors, oxidation ditched, contact stabilization plants, rotating biological contactors, and physical/chemical process.
- Land Application – Treated wastewater is applied to land through infiltration ponds, flood basins, sprinklers, or drip systems. Native soils play additional roles in adsorption and microbiological treatment of wastewater. The application can be used in combination with additional hydraulic controls such as underdrains and/or wells. Additionally, treated water can be used at agronomic rates and beneficially reused for crop irrigation.
- Precipitation/Coagulation/Flocculation/Sedimentation – Precipitation is often used to remove metals prior to other treatment process. Coagulants and flocculation are used to increase particle size through aggregation leading to sedimentation or flocculent settling.
- Rock Media Polishing Filter For Lagoons - Rock filters are used to remove algae from lagoon or pond effluents prior to discharge.
- Reverse Osmosis – The use of a semipermeable membrane and pressure to remove contaminants from water through a process of ion exclusion, which concentrates rejected ions into a brine or high strength waste stream.
- Side Stream Nutrient Removal – Nutrient loads from rejected wastewater (side stream) are often reintroduced into the treatment system accounting for 15 to 30% of the total load. Separating out the waste streams can improve the final effluent nutrient concentrations.

Other Treatments/Actions Compliance Measures

- Offsite Disposal - Contaminated soils, sludge, septage and contaminated groundwater removed from a site through excavation or pumping must be treated for onsite reuse or disposed of. Soil is often excavated separated and treated based on the concentration of contamination. Often, hazardous or near hazardous levels will be transported offsite for treatment or disposal. Depending on the locality of a site, treated groundwater may be disposed of into a sewer system, storm drain, to land or surface water.

5.4.2 Analysis of Compliance Measures to Address the Dissolved Oxygen Water Quality Objective in Surface Waters

The conceptual model for DO (Appendix E, Figure 1) specifically identifies the following activities as influencing the presence of DO in an aquatic system: agricultural practices, forestry practices, fossil fuel extraction and refinement practices, other mining practices, construction practices, residential and commercial practices, recreational practices, and industrial practices. These activities have the potential to act as sources of: fire ash and smoke, animal wastes, mining wastes, septic system leachate, landfill leachate, fertilizers, vehicle emissions, industrial emissions, sewage treatment plant effluent, industrial effluent, storm water discharge, and other historic or existing sources. In addition, these activities have the potential to alter environmental conditions in such way as to alter the natural cycle of DO availability. For example, the installation of impoundments, alteration of land cover, alteration of the stream channel, increase in temperature, or increase in sediment delivery can impact the functioning of DO in an aquatic system. Additionally, proactive restoration measures such as increasing the availability of channel forming material (e.g., large woody debris) in the stream channel, riparian zone, and floodplain are crucial to aquatic ecosystem function and recovery.

As such, the conceptual model illustrates the importance of developing management measures designed to reduce the threat of:

- Discharge of anthropogenic sources of nutrients, organic matter and water/wastewater low in DO, including the discharge of agricultural return flows;
- Discharge of warm water to a waterbody, including the discharge of agricultural return flows;
- Anthropogenic sources of erosion and sediment delivery;
- Direct alteration of the stream channel, such as through gravel mining;
- Disturbance to wetlands, the flood plain and riparian zone;
- Anthropogenic alteration to the natural pattern and range of flows, including storm water management, groundwater protection, and control of water impoundment and withdrawal; and
- Loss or alteration (e.g., reduction in flow or increase in temperature) of cold water spring.

It further illustrates the importance of developing management measures designed to control vehicle and industrial emissions. This task, however, is out of the range of the Regional Water Board's authority.

Conventional Wastewater Treatment

- Primary treatment (e.g., screening, grit removal, and primary sedimentation)
- Secondary treatment (e.g., attached growth process or suspended growth process of biological treatment)
- Advanced treatment (e.g., nitrification/denitrification, coagulation-sedimentation, carbon adsorption)
- Disinfection (e.g., chlorination/declorination, ozone)

Aquatic Ecosystem Restoration

- Stabilize stream crossings to provide controlled access across a stream for livestock

and farm machinery.
- Stream or river bank revegetation to increase shade in accordance with site potential.
- In-stream gravel augmentation.
- Large woody debris/habitat enhancement projects.
- Stream or river bank stabilization with native vegetation or other bioengineering techniques, the primary purpose of which is to reduce or eliminate erosion and sedimentation and support site potential shade.
- Culvert replacement conducted in accordance with published guidelines of the Department of Fish and Wildlife or National Marine Fisheries, the primary purpose of which is to improve habitat, provide shade, reduce sedimentation, or provide access to areas of thermal refugia.
- Re-establish native wetland and upland vegetation.
- Recreate historic channels.
- Restore historic oxbow channels to allow continuous flow.
- Breach lakeshore levees to create diverse habitat features.
- Lower lake levees to create riparian fringe habitat.

Oxygenation of stored water/wastewater/tailwater
- Specific to wastewater holding ponds, treatment methods include using ponds which circulate contaminated water via pumps, fountains, paddlewheels, jets, or subsurface compressed air bubbles. These ponds are effective at removing BOD and TSS in wastewater influent as a component of a multi-part treatment train
- Application of fine bubbles
    - Using unconfined fine bubble diffuser
    - Using unconfined and diffuse bubble curtain
- Specific to a reservoir, use of a bubble-free system in which a pressurized container placed at the bottom of the reservoir is used to mix water with gas and the mixture is dispersed over the sediments. The system is operated as soon as monitoring indicates that dissolved oxygen levels in the hypolimnion are starting to drop (early spring) and through the summer/fall.
- Oxygen supply facilities would include a liquid oxygen storage tank, vaporizers, and trucked-in oxygen to be used at locations midway along the reservoirs.
- Small onsite oxygen generators might also be used to supply oxygen near the dams

Nutrient Management
The goal of proper nutrient management is "to minimize nutrient losses from agricultural lands occurring by edge-of-field runoff and by leaching from the root zone" (USEPA 2003). USEPA (2003) describes four important elements to successful nutrient management: 1) determine realistic yield goals, preferably on a field-by-field basis, 2) account for available nutrients from all sources before making supplemental applications, 3) synchronize nutrient applications with crop needs (nitrogen is needed most during active crop growth and may be lost at other times), and 4) reduce excessive soil-phosphorus levels by balancing phosphorus inputs and outputs. Where nutrients are in the dissolved phase,

source reduction and reduction of water runoff or leaching are important goals. For nutrients adsorbed to soil particles, the prevention and control of soil erosion is important.

- Monitor soil, irrigation water, and residual plant matter for nutrient content.
- Time fertilizer application to be consistent with plant needs to avoid runoff of excess nutrients to surface waters or leaching of excess nutrients to groundwater.
- Use appropriately sized vegetated buffers to prevent discharge of nutrients to surface waters.

Pesticide Management

The goal of proper pesticide management is to reduce contamination of groundwater and surface water from pesticides by using less pesticide (quantity), less toxic (toxicity) pesticides, and applying pesticides in a manner that reduces the risk of runoff, leaching or air-borne transport. With respect to the chemical constituents, toxicity and DO, the application of herbicides is of most relevance. For example, herbicides applied to drainage channels or applied in such a manner as to risk overspray to a water body or riparian zone, could result in an increased risk of organic matter loading as treated plants die and their organic matter is available for delivery to a stream. Similarly, the spraying of herbicides in a riparian zone or overspray from adjacent fields could result in the temporary loss or harm to riparian shade. Additionally, over application of pesticides has the potential to adversely impact both human and aquatic life through adsorption and ingestion if pesticide levels accumulate in drinking water supplies or recreational areas.

- Inventory pest problems.
- Evaluate the soil and physical characteristics of the site, including locations for safe mixing, loading, and storage of pesticides.
- Use integrated pest management strategies that apply pesticides only to the area of need, only when there is an economic benefit to the grower, and at times when runoff losses are least likely, including losses of organic matter from dead plant material.
- Consider the persistence, toxicity, runoff potential, and leaching potential of pesticide products.
- Periodically calibrate pesticide application equipment.
- Use anti-backflow devices on water supply hoses, and other mixing/loading practices designed to reduce the risk of runoff and spills.

Restore and Maintain Site-Specific Potential Effective Shade

- Increase riparian and in-channel tree canopy retention for surface waters to support beneficial uses.
- Limit development and harvest actions in riparian areas to attain site potential shade.
- Develop a grazing management plan for upland and riparian management.
- Calculate the timing and number of livestock that can be accommodated while maintaining adequate vegetative cover, stream corridor integrity, and water resources.

- Establish native or introduced forage species (grasses, forbs, legumes, shrubs, and trees) through pasture, field, orchard and rangeland planting.
- Implement the controlled harvest of vegetation with grazing or browsing animals to achieve a specific objective.
- Exclude animals, people, or vehicles from an area to protect, maintain, or improve the quantity and quality of riparian vegetation.
- Construct animal trails to provide movement of livestock through difficult or ecologically sensitive terrain.
- Stabilize stream crossings to provide controlled access across a stream for livestock and farm machinery.
- Plant vegetation to increase shade in accordance with site potential.

Variable Outlet Structure
A variable outlet structure allows the operator to draw water from various depths in the reservoir. This flexibility allows the operator to respond to water quality conditions of the reservoir and the water quality needs of the river downstream so as to release water that most closely meets the overall environmental objectives.

- Install coffer dam
- Install necessary infrastructure for outlet

Erosion and Sediment Control
Structural erosion and sediment control compliance measures:

- Soil conservation cover straw cover, bonded fiber matrix, grass seeding, temporary plastic cover, residue tillage, heavy use area protection, strip cropping.
- Silt fence, straw waddle, straw bale, gravel check dam, gravel bag berm, stock pile cover.
- Sediment control basin, pond, embankment pond.
- Riparian buffer/filter strip, grassed waterway/bioswale.
- Active sediment treatment system.
- Culverts, stream crossings, water diversions, bridges.
- Bench contouring, contour farming, terrace, vegetated windbreak/hedgerow planting.
- Exclusionary fences.
- Micro-irrigation systems.
- Lined irrigation channels.
- Rock slope protection, lined waterway/outlet, road/trail access control, underground outlet, vertical drain.
- Road/trail landing closures/treatment, forest trails and landings.
- Slide stabilization, soil stabilization or fill and cut slopes, removal of unstable fill.
- Low impact development (LID) to maintain the predevelopment hydrograph to sustain site runoff volume and velocity to attain sediment and water discharge equilibrium within streams.
- In-stream bioengineering.

- In-stream and riparian planting.
- Stream bank/shoreline protection.
- Road surface materials, paving, chip sealing, rocking, dust abatement. Establish native or introduced forage species (grasses, forbs, legumes, shrubs, and trees) through pasture, field, orchard and rangeland planting.
- Exclude animals, people, or vehicles from an area to protect, maintain, or improve the quantity and quality of riparian vegetation.
- Construct animal trails to provide movement of livestock through difficult or ecologically sensitive terrain.
- Stabilize stream crossings to provide controlled access across a stream for livestock and farm machinery.

Non-structural erosion and sediment control compliance measures:

- Dry weather construction or harvest scheduling.
- Inventory excessive sediment delivery sites, prioritize sites by threat to water quality, design and plan remediation, track and report remediation implementation success.
- Road drainage design, disconnect road drainage from watercourses (drain to hill slopes), install drainage structures at intervals to prevent erosion of the inboard ditch or gull formation at the hill slope outfall, outslope roads.
- Timing and intensity of road use.
- Proximity of roads to watercourses.
- Proximity of roads to unstable or landslide prone areas.
- Develop a grazing management plan for upland and riparian management.
- Calculate the number of livestock that can be maintained while maintaining adequate vegetative cover, stream corridor integrity, and water resources.

<u>Tailwater and Surface Impoundments</u>
Structural compliance measures:

- Pond, embankment pond.
- Riparian buffer/filter strip, grassed waterway/bioswale.
- Lining of an irrigation channel.
- Installation of a pipeline in lieu of an uncovered channel.
- Install surface drainage field ditch to collect excess water.
- Minimize discharge from edge of fields.
- Construct tailwater management system.
    - Construction of a reservoir and pumping facilities.
- Land leveling to prevent discharge from field edges to surface waters.
- Construct off-stream retention ponds for evaporating and percolating tailwater.
- Control structures for irrigation.
- Micro-irrigation systems.
- Dam removal.
- Bypass flow structures.

- Aeration systems.

Non-structural BMPs/compliance measures:
- Irrigation management plans to operate the irrigation system so that the timing and amount of irrigation water applied matches crop needs.

Preserving Cold Water Resources
- Avoid of areas of known thermal refugia during critical time for fish.
- Control of erosion and sediment discharges to areas of known thermal refugia.
- Remove fish passage barriers to areas of known thermal refugia.
- Conduct streambank restoration and riparian revegetation to areas of known thermal refugia.
- Construct riparian fencing to preserve areas of known thermal refugia
- Modify and/or remove on-stream storage facilities and dams which influence identified cold water resources.
- Construct new or modify off-stream storage facilities to replace on-stream facilities affecting cold water resources.
- Install and operate groundwater wells at a location with little or no influence over the flows associated with a cold water resource.
- Modify the operation and timing of groundwater, surface water, or riparian right water extraction.
- Rely on alternative water sources and conservation efforts.
- Construct and/or modify water transfer, irrigation and/or irrigation water management facilities to improve water use efficiency.
- Enhanced aquifer recharge (i.e., ASR).

Maintain Stream Flows that Support Beneficial Uses
- Construct, modify and/or remove on-stream storage facilities and dams.
- Construct new or modify off-stream storage facilities.
- Install and operate groundwater wells.
- Modify the operation and timing of groundwater, surface water, or riparian right water extraction.
- Rely on alternative water sources and conservation efforts.
- Construct and/or modify water transfer, irrigation and/or irrigation water management facilities.
- Enhanced infiltration of groundwater (i.e., ASR)

Source Controls
Source controls are accomplished through existing local, state and federal authorities and includes a wide range of potential actions such as TMDLs, best management practices, the storm water programs, point source treatment controls, safe medicine disposal programs and pretreatment programs. It is not possible to evaluate the environmental effects of source control per se; one must evaluate the specific source control measure on a site-

specific basis. It is not reasonably feasible at this time to evaluate the environmental effects of these hypothetical source control projects or mitigation measures for such hypothetical actions.

While adverse impacts are a possible consequence of source control measures for some sites, these impacts may be minimized or avoided by the implementation of a watershed management approach that balances the potential impacts (and cost effectiveness) of correcting a contaminated site or preventing high strength wastes from overloading treatment facilities or systems. The watershed management approach should involve point and nonpoint dischargers in addressing pollution prevention and remediation. Consequently, the environmental impact of source control efforts that result from a watershed management effort should be analyzed on a site-specific basis once the sites have been selected, and the function and general designs of the actions or facilities have been determined.

Watershed management is actually a process, rather than a regulatory requirement, and it is not possible to evaluate the physical environmental effects of such a process. Compared to the more traditional programmatic, regulatory approach to water management the watershed approach looks at all types of pollution and all sources of pollution. In a collaborative, stewardship effort, local interests are engaged with state and federal interests, and land managers to work with water managers to solve complex resource management problems. The purpose of watershed management is variously viewed as (1) a method for increasing participation at the local level in water quality protection, (2) an approach to reducing the impact of nonpoint sources, (3) a strategy for integrating management of all components of aquatic ecosystems, and (4) a process for optimizing the cost effectiveness of a number of point and nonpoint source control efforts.

Watershed management is not a new centralized program that replaces existing programs. The significant advantage of a watershed management approach is it encourages a collaborative process where diverse interests (i.e., individuals, landowners, growers, municipal agencies, industries, environmental groups and agencies) can work in conjunction with the State Water Board and Regional Water Board staff to develop a consensus on approaches for addressing water quality problems. Further, watershed management provides a mechanism for considering social and economic interests in the context of solving water quality problems.

Taking a comprehensive approach to addressing pollution problems where point and nonpoint source pollution is considered together provides an opportunity to minimize environmental impacts of future pollutant reductions and consider cost-effectiveness together. It is impossible to predict the outcome of this combined process before it is completed. The potential impacts and mitigation depend on future decisions of watershed groups and the Regional Water Board.

5.4.3 Potential Environmental Impacts and Mitigation Measures Associated with Compliance Measures to Address Chemical Constituents, Dissolved Oxygen and Toxicity Water Quality Objectives

As noted in Chapter 2 of this Staff Report water quality objectives already exist for chemical constituents and DO for surface water and for groundwater. Additionally, a water quality objective for toxicity exists for surface water. It is acknowledged that the proposed Basin Plan amendment would remove existing numeric objectives and replace them, in some cases, with more stringent objectives with potential for those objectives to become even more restrictive as MCLs are modified in the future. Through the application of footnote 2 to the existing Table 3-2 of the Basin Plan, however, altered MCLs and other more stringent requirements are already applied. So in reality, the only truly new objective is the proposed groundwater toxicity objective. This point is highly relevant to an environmental impact analysis as the compliance measures used to address groundwater toxicity in most cases already exist and are being implemented throughout the North Coast Region.

It should be reiterated that the existing regulatory framework uses natural background conditions as the applicable water quality objective in actual and potential impacts to beneficial uses. In turn it can be debated as to whether or not a groundwater toxicity objective will result in numeric values beyond what already exists within the Regional Water Board current authorities. See Figure 3-1 for an illustration of this point. Nevertheless, staff has developed an analysis of the potential adverse impacts to the environment from compliance measures for groundwater and surface water chemical constituents and toxicity to eliminate any doubt of CEQA compliance. This chapter also includes analysis of potential adverse impacts to the environment from compliance measures associated with the proposed DO objective.

The resources that may be adversely affected by the reasonably foreseeable compliance measures are protected by a number of existing regulations and agency policies, as well as policy-level mitigation measures incorporated in this Staff Report. Based on the regulatory requirements to protect the environment at the project level and the policy-level mitigation measures identified, persons implementing remediation will take a number of steps to ensure that potentially significant environmental impacts are avoided, minimized and/or mitigated. Table 5-1 presents the potential resources that could be adversely affected by compliance measures as a result of the proposed WQO Update Amendment, as well as mitigation measures to reduce the level of significance.

The policy-level mitigation measures contained in this Staff Report differ from future project-specific mitigation measures in that they address potential adverse impacts on a broad and generic level. In this regard, they help direct how and when project-specific measures may be needed to avoid or mitigate potential impacts, but they do not replace the need for project-specific environmental review or mitigation measures.

Many of the policy-level mitigation measures discussed in this document are restatements of existing federal and/or state laws and policies. Project proponents will evaluate proposed remediation plans consistent with these federal and state requirements (e.g., CEQA, Clean Water Act, Porter-Cologne Water Quality Control Act, Endangered Species Act, etc.). The inclusion and coordination of these measures as part of compliance measures implementation should help to minimize adverse environmental effects.

The categories of resources that the Regional Water Board has identified as potentially being impacted by the implementation of compliance measures include:[8]

- Aesthetics;
- Agriculture;
- Air quality;
- Biological resources;
- Cultural resources;
- Geology and soils;
- Hazards and hazardous materials;
- Hydrology and water quality;
- Land use / planning;
- Noise;
- Public Services;
- Transportation/traffic; and
- Utilities and service systems.

Aesthetics

- Decreased views or unsightly presence in a scenic vista due to the installation of additional mitigation or remediation equipment or associated material storage necessary to cleanup spills, unauthorized releases, treat wastewater, physically address DO.
- Unsightly views of additional wastewater treatment ponds, waste management/treatment units, structural oxygenation facilities.
- Potential glare from ponds or unsightly water facilities.
- Decreased scenic views of waterbodies through the retention of vegetation.

Possible Mitigation Measures

- AesMM-1: Building storage facility structures or fences to contain equipment or materials.
- AesMM-2: Proper siting, constructing berms or excess freeboard around the perimeter of a ponds or waste management unit.
- AesMM-3: Planting vegetation such as native trees, grasses, and forbs.

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8 See CEQA Checklist (Section 5.5.2)

Agriculture

- Potential conflict with or conversion of prime agricultural land or land subject to the Williamson Act from implementing grazing restrictions, riparian buffers, or riparian restoration.
- Municipal, domestic, agricultural and industrial water supply could be impacted by certain restrictions on the extraction of water from riparian areas or areas of known thermal refugia.
- Switching from surface water diversions to groundwater pumping could lower water table, reduce soil moisture, contribute to land subsidence and reduce aquifer storage capability.
- Regulation on water use could lead to the conversion of agricultural lands.

Possible Mitigation Measures

- AGRMM-1: Coordination between project proponents, Regional Water Board staff and other local, state and federal agencies to achieve site-specific potential effective shade, nutrient load reductions, areas of thermal refugia and attempt to ensure the preservation of agricultural lands.

Air Quality

- Construction-related emissions could include exhaust, fugitive dusts, toxic pollutants and particulate matter (PM10 and PM2.5) from construction equipment and fugitive dust from land clearing, earthmoving, movement of vehicles, and wind erosion of exposed soil during reservoir construction or removal, stream and/or riparian restoration.
- Additional source control treatment measure upgrades for publically owned treatment works or soil, water or vapor remediation systems could result in an increase in greenhouse gas emissions due to increased power consumption.
- Potential for increased odors from excavation and exposure of contaminated soil, slurry, or sludge.
- Potential odors from stagnant water in sediment basins or ponds.
- Potential byproducts from reducing agents to treat soil and/or groundwater include airborne hydrogen sulfide, vinyl chloride, methane which can produce nuisance or toxicity.
- Potential increase in emissions from transportation of soil and groundwater for offsite disposal.
- Electrodialysis produces hazardous gasses, such as chlorine, hydrogen, and hydrogen sulfide.
- Extended operation and maintenance of remedial action facilities.
- Thermal destruction incinerators produce off-gas that requires treatment by an air pollution-control system to remove particulates and neutralize and remove acid gases (e.g., HCl, NO_x, and SO_x).

- Alternative water supplies or increased pumping could result in long-term increase in greenhouse gases.

Possible Mitigation Measures

- AQMM-1:Air Quality Control Plans
  - Monitoring and Reporting
  - Dust control
  - Avoid days of poor air quality
  - Monitor levels and cease work prior to exceeding standards
  - Retrofit equipment
  - Use low emissions vehicles when possible
  - Schedule work to reduce the use of high emission vehicles.
  - Contingency Plans for AQ Violations
- AQMM-2: Particulate matter and gas removal systems
  - Baghouses, scrubbers, and wet electrostatic precipitators; packed-bed scrubbers and spray driers.

Biological Resources

- Installation or expansion of remediation or treatment facilities and/or aquatic ecosystem restoration can directly and indirectly impact species through habitat modification or by exceeding water quality objectives.
- The use of phytoremediation could result in the transfer of contaminants across media from soil and water to air.
- The use of phytoremediation could result in bioaccumulation of toxic compounds if primary producing organisms became prey for threatened or endangered species.
- Risk of introducing invasive species thorough pasture, hay and rangeland planting and management.
- Risk of conflict between site potential shade and requirements of sensitive flora or fauna.
- Operations of aeration systems for DO have the potential to supersaturate conditions and lead to accelerated mortality rates of salmoninds and other sensitive species.
- Short-term construction, stream dewatering or diversions, turbidity discharges from construction actives or in-stream dam removal, stream and/or riparian restoration.
- Several species of fauna (e.g., snakes, fish, salamanders, and birds) have been entrapped or tangled in erosion control products such as the plastic casing covering straw waddles, or from the monofilament fibers from silt fences that are either in place on active.
- Loss of wetlands habitat from repair of leaky conveyance systems or alteration of irrigation practices.
- Switching from on-stream storage facilities to springs, seeps or groundwater

as potential water sources could reduce the input of groundwater to surface waters and could results in impacts to areas of thermal refugia.
- Loss of critical habitat from sediment discharges.
- Loss of warm water habit for non-native species.
- Reduction in surface flows through groundwater extraction or increased reliance on riparian rights could degrade riparian and special status species habitat.

Possible Mitigation Measures
- BRMM-1: Consult the applicable state and federal resource protection agencies
- BRMM-2: Delineate and avoid any project specific environmental sensitive areas.
- BRMM-3: Identify species-specific work windows to avoid contact or disturbances.
- BRMM-4: Compensatory mitigation to create, replace, or restore filled or modified waters of the U.S. (streams and wetlands).
- BRMM-5: Remedial action plans proposing phytoremediation would need to evaluate the potential for bioaccumulation of toxic compounds and select plans species that will not become primary producers in the food chain.
- BRMM-6: Use certified weed-free grass and seed mix to prevent the introduction of invasive species.
- BRMM-*7:* Select appropriate or alternate structural BMPs such as bio-degradable, synthetic free or earthen material BMPs. Implement non-structural BMPs such as scheduling, proper design and the removal of temporary BMPs for erosion and sediment controls after stabilization and or project completion.
- BRMM-8: Developing species relocation plans or interpreting natural site vegetative conditions to include sensitive flora.
- BRMM-9: Water drafting protocols
    - Consult CA Fish and Wildlife
    - Consult SWRCB – Water Rights
    - Use water diversion fish screens
    - Velocity dissipaters
    - Habitat surveys
    - Stream buffers
- AQMM-1: Air Quality Control Plans
    - Monitoring and Reporting
    - Contingency Plans for AQ Violations
- H/WQMM-1: Develop storm water pollution prevent plans.
- H/WQMM-2: Water Quality Monitoring
- H/WQMM-3: Develop project-specific remedial action plans that take site characteristics including, geology, hydrology, environmental setting, and

onsite and nearby structures into account.

- H/WQMM-4: Implement flow rate modeling, monitoring, prohibitions and restrictions within specific Regional Water Board permits and orders.
- H/WQMM-5: Plant native vegetation that has evolved with the natural environment. Allow for the removal or thinning of upland vegetation that has high evapotranspiration rates and increases fire risks.

Cultural Resources

- Construction disturbance from earth moving associated with riparian restoration, installation of soil/groundwater remediation facilities, waste water treatment facility upgrades or expansions, monitoring well installations, excavations, ponds and lagoon construction, and physical barriers to contain contamination.
- Construction disturbance from earth moving associated with implementation of aquatic ecosystem restoration erosion and sediment controls.
- Construction disturbance from earth moving associated with measures to address tailwater, surface water impoundments, preservation of cold water resources, and measures to restore and maintain stream flows have the potential to impact culturally and historically significant sites.

Possible Mitigation Measures

- CRMM-1: Consult with Tribes, historical societies, federal, state and local agencies regarding location of cultural resources prior to use of heavy equipment in areas with known or suspected cultural resources. Projects subject to the jurisdiction of the Water Boards will be required to comply with Public Resource Code section 21159. This is expected to ensure the implementation of necessary project-specific actions to avoid, minimize and mitigate any impacts to historical, archaeological, and paleontological resources or site, or unique geologic features. All future actions must comply with the CEQA process and requirements for tribal consultation provided by Senate Bill 18 (SB 18) (State 2004, Ch 905) and Government Code section 65252.

Geology and Soils

- Implementation of compliance measures such as wells, ponds, trenches, excavations and other treatment facility expansions that involve construction may result in temporary ground disturbances that cause erosion.
- Soil excavation and trenching could result in erosion or soil collapse.
- Potential soil erosion from disturbed areas associated with stream stabilization, stream bank revegetation, culvert replacement, stream crossing construction, large woody debris placement.
- Construction activities or poorly designed facilities could result in short-term and long-term erosion, and could result in soils compaction reducing soil

moisture and biological functions.

Possible Mitigation Measures

- H/WQMM-1: Develop storm water pollution prevent plans.
- GSMM-1: Include erosion control measures in facility pollution prevent plans, remedial action plans, or site health and safety plans.
- H/WQMM-3: Develop project-specific remedial action plans that take site characteristics including, geology, hydrology, environmental setting, and onsite and nearby structures into account.

Hazards and Hazardous Materials

- Accidental spill or release of materials which have been removed from soil and or groundwater though a remediation actions, wastewater treatment facilities or from the construction of compliance measures.
- Natural attenuation if not monitored correctly could result allow the migration of hazardous substances.
- In-situ and ex-situ physical, chemical and thermal remediation or treatments, by design, have the potential to create byproducts or mobilize pollutants in air, soil, and water.
- Physical, chemical and biological treatment of wastewater has the potential to create byproducts or mobilize pollutants in air and water.
- Increased amounts of compressed oxygen or compressors that may require fuels to operated.
- Construction and operation of reservoir or stream aeration structures.

Possible Mitigation Measures

- H/WQMM-1: Storm Water Pollution Prevent Plans
- H/WQMM-2: Water Quality Monitoring
- H/WQMM-3: Develop project-specific remedial action plans that take site characteristics including, geology, hydrology, environmental setting, and onsite and nearby structures into account.
- AQMM-1: Air Quality Control Plans
    - Monitoring and Reporting
    - Contingency Plans for AQ Violations
- HHMMM-1: Project-specific health and safety plans

Hydrology/Water Quality

- Soil excavations, compost operations or land farming could result in erosion, sedimentation of nearby waters.
- During the reductive de-chlorination process, metals, such as arsenic, manganese and antimony, may be mobilized in the subsurface.
- PCE is reductively de-chlorinated to Trichloroethylene (TCE), cis- and trans-

1,2-DCE and vinyl chloride (VC).

- Ozone injection can cause chromium III to turn into a more toxic and bioavailable chromium VI.
- Fracturing hydraulically separate zones could lead to cross contamination of uncontaminated aquifers, water bearing zones, or nearby surface waters.
- Pump and treat systems could result in a lowering of the groundwater table or an alteration of hydrology by impeding the natural groundwater gradient.
- Pump and treat systems could alter a site's hydrology and adversely affect nearby streams, riparian areas or wetlands.
- Pump and treat systems could result in the alteration of nearby stream hydrology adding to the total flow in the stream.
- Improper or partial application of wastewater treatment methods/chemicals could have adverse effects on effluent water quality.
- Land application of wastewater could result in groundwater quality impacts through the accumulation of organics, salts, or precipitation of naturally occurring metals in soils.
- Reduction in stream flows due to the increase in evapotranspiration from increased riparian tree retention. Temporary sediment discharges from construction and/or restoration activities.
- Temporary sediment discharges that exceed water quality objectives from construction and/or restoration activities.
- Excessive use of rip-rap or stream stabilization structures intended to beneficially affect flow could alter conditions downstream.
- Work within and adjacent to waters increases the risk of leaking equipment or hazardous material spills, short-term turbidity increases and/or discharges of settable solids.
- Breaching lakeshore levees to create diverse habitat features and lower lake levees to create riparian fringe habitat has the potential to adversely affect hydrology and natural flow patterns.
- Operations of aeration systems for DO have the potential to supersaturate conditions, exceed water quality standards and lead to accelerated mortality rates of salmoninds and other sensitive species.
- Decrease stream flows and/or aquifer storage from dust abatement.
- Alterations of natural hydrology and increases in stream temperatures by concentrating or redirecting road runoff.
- Increased risk of soil or groundwater contamination with concentrated minerals, salts, or persistent pesticides.
- Increased risk of erosion and sedimentation from the construction of trails, stream crossings, and riparian grazing.
- Increase risk of groundwater contamination of petroleum hydrocarbons and metals from the infiltration of storm water runoff.
- The removal of surface water impoundments could result in a short-term violation of water quality standards as sediments and organic rich waters

flow downstream.
- The increase in groundwater extraction could reduce surface water flows and result in increased pollutant concentration due to less dilution.
- The removal of on-stream and off-stream storage facilities, dams, and construction of minimum bypass flow and fish passage structures could result in changes to hydrology in streams as well as short-term violation of water quality standards.
- Switching from on-stream storage facilities to springs, seeps or groundwater as potential water sources could reduce the input of cold water and could results in impacts to areas of thermal refugia.

Possible Mitigation Measures
- H/WQMM-1: Storm Water Pollution Prevent Plans
- H/WQMM-2: Water Quality Monitoring
- H/WQMM-3: Develop project-specific remedial action plans that take site characteristics including, geology, hydrology, environmental setting, and onsite and nearby structures into account. Ensure proper design, siting, and operational timing to reduce alterations of natural hydrology and adverse effects on stream and groundwater quality and quality from structural compliance measures.
    - Install and maintain erosion control measures (e.g. waterbars, rolling dips, mulch, rock rip-rap) to prevent discharge of excess sediment from soil disturbing activities.
    - Relocate roads away from unstable and landslide prone terrain. Drain roads away from unstable areas during construction, reconstruction of maintenance activities. Locate new roads on stable ground to the maximum extent practicable.
    - Minimize cutbank height and avoid placement of fill on steep slopes. Use off-channel water collection features for dust abatement purposes.
    - Install adequate number/type of road drainage features to prevent concentration of road runoff.
    - Seek professional (e.g. Natural Resources Conservation Service, local resource conservation district) in developing land management plans and observational techniques to ensure optimal stocking rates for rangelands.
    - Protect drainage channels from sediment contributions with vegetated buffers, wattles or similar erosion control devices.
    - Plant a cover crop on exposed soil to reduce the length of time in which soil is exposed to wind and water. Cover exposed soil that will not receive immediate planting with straw or other suitable erosion control material.

- Use precision (site-specific) farming techniques; monitor chemical condition of soil, water, and plant residuals carefully prior to applying fertilizers, pesticides, or water, including tailwater.
- Leach soils within the root zone as necessary to prevent salt build up in that portion of the soil profile.
- Avoid introduction of storm water into tailwater system to prevent impacts to storm water.
- Maintain filter strips between fields and surface water to prevent discharge of tailwater directly into surface waters.
- Don't concentrate drainage such that toxic levels of constituents are discharged to waters.

- H/WQMM-4: Implement flow rate modeling, monitoring, prohibitions and restrictions within specific Regional Water Board permits and orders.
- H/WQMM-5: Plant native vegetation that has evolved with the natural environment. Allow for the removal or thinning of upland vegetation that has high evapotranspiration rates and increases fire risks.

Land Use Planning

- The groundwater toxicity objective could present a conflict with groundwater management strategies such as aquifer storage and recovery.
- Installation or expansion of remediation or treatment facilities may have a potential for direct and indirect impacts to a candidate, sensitive, or special status species or their habitat and could conflict with applicable conservation plans.
- Reliance on alternative water sources, water conservation efforts, and preservation of areas of known thermal refugia could have a conflict with local plans or ordinances that call for an increase through various water supply and/or development projects.
- Municipal, domestic, agricultural and industrial water supply could be impacted by certain restrictions on the extraction of water from riparian areas or areas of known thermal refugia. Construction or expansion of off-stream water storage facilities could conflict with local plans or ordinances.

Possible Mitigation Measures

- BRMM-1: Consult the applicable state and federal resource protection agencies
- BRMM-2: Delineate and avoid any project specific environmental sensitive areas.
- BRMM-3: Identify species-specific work windows to avoid contact or disturbances.
- BRMM-4: Compensatory mitigation to create, replace, or restore filled or modified waters of the U.S. (streams and wetlands).
- BRMM-5: Remedial action plans proposing phytoremediation would need to

evaluate the potential for bioaccumulation of toxic compounds and select plants species that will not become primary producers in the food chain.

- H/WQMM-1: Develop storm water pollution prevention plans.
- H/WQMM-2 Water Quality Monitoring.
- H/WQMM-3: Develop project-specific remedial action plans that take site characteristics including, geology, hydrology, environmental setting, and onsite and nearby structures into account. Ensure proper design, siting, and operational timing to reduce alterations of natural hydrology and adverse effects on stream and groundwater quality and quality from structural compliance measures.

Mineral Resources

- Preservation of riparian areas, riparian buffers, aquatic ecosystem restoration, and erosion and sediment controls could decrease access for gravel, gold or other mineral extraction activities.

Possible Mitigation Measures

- None (Less than significant)

Noise

- Temporary increase in noise from heavy equipment during remediation or treatment system installation.
- Temporary increase in noise from trucks and heavy equipment during excavations.
- Temporary increase in noise from drill rigs installing monitoring wells, injection wells, or extraction wells.
- Use of pumps, mixers, and compressors to sample, remediate and treat water.
- Use of thermal treatment units/incineration can produce noise above ambient levels.
- Switching from surface water supply to groundwater pumping could result in increases in noise.
- Construction, modification or removal of facilities for the purpose of groundwater or surface water extraction, energy supply and/or recreation could result in short-term and long-term impacts from noise.
- Aquatic ecosystem restoration, and erosion and sediment controls could increase noise from use of heavy equipment.
- Permanent increases in noise from wastewater treatment facility upgrades or from decade-long cleanup projects.

Possible Mitigation Measures

- NOMM-1: Noise Control Plans
  - Decibel monitoring

- Peak noise working hours
- Evening working hours
- Equipment inspection
- Muffler inspections
- Nearby receptors
- Compliant process plan
- Operations contingency plan

- NOMM-2: Advanced notifications
- NOMM-3: Sound control structures
- NOMM-4: Equipment buffers

Population and Housing

- Water conservation and/or reliance on alternative water sources could have an impact on housing development or existing housing populations.
- Moving to reliance on larger water suppliers could increase their demand and thus lead to an increased level of water extraction in specific locations.

Possible Mitigation Measures

- None (Less than significant)

Public Services

- Retaining and preserving riparian areas can lead to increases in forest fires leading to an increased demand on fire services.
- Increased enforcement on sediment discharges from illegal cultivations could lead to an increased demand in local, state and federal law enforcement resources. Increased burden on vector control from wetland creation and sediment control basins.

Possible Mitigation Measures

- H/WQMM-5: Plant native vegetation that has evolved with the natural environment. Allow for the removal or thinning of upland vegetation that has high evapotranspiration rates and increases fire risks.

Transportation/Traffic

- Temporary increase in truck traffic from the construction or expansion of a remediation or treatment system or restoration project.
- Temporary increase in traffic from lane closures due to subsurface investigations.
- Temporary increase in traffic from excavation activities.
- Increased tree retention and riparian restoration may conflict with transportation agencies (public roads) site distance requirements and areas designated as clear recovery zones.
- Short-term traffic increases associated with sediment reduction project,

construction projects, dam removal, stream and/or riparian restoration.

Possible Mitigation Measures

- TTMM-1: Traffic Control Plans
  - Signage locations
  - Through traffic routes
  - Designated truck routes
  - Construction site access
  - Designated work and staging areas
  - Parking areas
  - Pedestrian and bicycle safety access
  - Detours and lane closures
  - Emergency access routes and detours
  - Flaggers
- TTMM-2: Night Work
- TTMM-3: Strategic planning and design to avoid and minimize the placement of facilities that have site distance conflicts. Case-by-case evaluations of site distance.
- BRMM-4: Compensatory mitigation to create, replace, or restore filled or modified waters of the U.S. (streams and wetlands).

Utilities and Service Systems

- Construction or demolition of facilities could result in short-term interruption of utilities.
- Dam removal, water conservation and/or reliance on alternative water sources could lead to short-term interruptions and could lead to a decrease in available water supply and landfill capacity.

Possible Mitigation Measure

- USSMM-1: Coordinate with the underground service alert system, and utility providers to develop project-specific plans to avoid and minimize any potential utility interruptions.
- USSMM-2: Develop waste management plans for dam removal projects. Coordinate with prospective landfills regarding the estimated amount of waste generated by a proposed project and landfill capacity.
- USSMM-2: Plan for and develop conservation and efficiency projects for water supply. Plan for and develop recycled water projects and aquifer storage and recovery (ASR) projects.

5.4.4 Discussion of Potential Environmental Impacts

Potential impacts of the reasonably foreseeable compliance measures were evaluated with respect to earth, air, water, plant life, animal life, noise, light, land use, natural resources, population, housing, transportation, public services, energy, utilities and services systems, human health, and aesthetics. Additionally, mandatory findings of significance regarding short-term, long-term, cumulative and substantial impacts were evaluated.

Thresholds of Significance

A significant effect on the environment is defined in statute as *a substantial, or potentially substantial, adverse change in the environment* where *Environment* is defined by Public Resources Code section 21060.5 as *the physical conditions which exist within the area which will be affected by a proposed project, including air, water, minerals, flora, fauna, noise, objects of historic or aesthetic significance*.[9]

Social or economic changes related to a physical change of the environment were also considered in determining whether there would be a significant effect on the environment. However, adverse social and economic impacts alone are not significant effects on the environment. A range of compliance measure costs and potential funding sources are discussed in Chapter 6 (Economic Considerations).

When assessing the significance of a potential environmental impact related to implementation of the proposed WQO Update Amendment, it is imperative to distinguish the level of mitigation possible under a proposed project versus a proposed policy. A complex policy could lead to several potential outcomes that are much more difficult to predict then would be the outcomes associated with a complicated project (e.g., a project set at one place in time that has many moving parts, but none the less has a quantifiable impact on the environment). Additionally, some potential mitigation measures proposed at the policy level may not be directly enforceable by the Regional Water Board at the project level, and therefore require re-evaluation when a specific project is under evaluation. For example, a potential mitigation measure to address air quality impacts as a result of a compliance measure designed to comply with water quality objectives is not directly enforceable by the Regional Water Board and shouldbe addressed and implemented at the project level.

Under California Code of Regulations, title 14, section 15064.7, public agencies are encouraged to develop and publish thresholds of significance for general use in the environmental review process, via ordinance, rules or regulations. However, an "ironclad definition of significant effect is not always possible because the significance of an activity may vary with the setting." (Cal. Code Regs., tit. 14, §15064, subd. (b)). Thresholds are intended to be analytic tools to assist in significance determinations, not rigid standards; and they should not result in de facto policy making. Thresholds may be either qualitative or quantitative. (See "Thresholds of Significance: Criteria for Defining Environmental Significance" (Sep. 1994) OPR, available at http://ceres.ca.gov/ceqa/more/tas/Threshold.html.)

[9] Pub. Resources Code §21068

This evaluation considers whether the construction or implementation of compliance measures would cause a substantial, adverse change in any of the physical conditions within the area affected by the measure. In addition, the evaluation considers environmental effects in proportion to their severity and probability of occurrence. In this analysis, the level of significance is based on the baseline or current conditions of both the physical environment and regulatory baseline. For example, impacts associated with the construction of compliance measures are considered less than significant with mitigation because the impacts due to construction activities are temporary and similar to typical groundwater remediation, wastewater treatment projects and their associated maintenance activities currently required and performed throughout the region.

Categorical Exemptions

CEQA allows for the application of categorical exemptions for the project specific implementation of many of the compliance measures that will not have a significant effect on the environment. For example, CEQA Guidelines section 15330 (Class 30),*Minor Action to Prevent, Minimize, Stabilize, Mitigate or Eliminate the Release or Threat of Release of Hazardous Waste or Hazardous Substances* is commonly used for the assessment and remediation of groundwater cleanup sites. This exemption applies to small or medium removal actions costing $1 million or less and is commonly used throughout the state as long as the following criteria are met:

(a) No cleanup action shall be subject to this Class 30 exemption if the action requires the onsite use of a hazardous waste incinerator or thermal treatment unit or the relocation of residences or businesses, or the action involves the potential release into the air of volatile organic compounds as defined in Health and Safety Code Section 25123.6, except for small scale in situ soil vapor extraction and treatment systems which have been permitted by the local Air Pollution Control District or Air Quality Management District. All actions must be consistent with applicable state and local environmental permitting requirements including, but not limited to, offsite disposal, air quality rules such as those governing volatile organic compounds and water quality standards, and approved by the regulatory body with jurisdiction over the site.

(1) Removal of sealed, non-leaking drums or barrels of hazardous waste or substances that have been stabilized, containerized and are designated for a lawfully permitted destination;

(2) Maintenance or stabilization of berms, dikes, or surface impoundments;

(3) Construction or maintenance or interim of temporary surface caps;

(4) Onsite treatment of contaminated soils or sludges provided treatment system meets Title 22 requirements and local air district requirements;

(5) Excavation and/or offsite disposal of contaminated soils or sludges in regulated units;

(6) Application of dust suppressants or dust binders to surface soils;

(7) Controls for surface water run-on and run-off that meets seismic safety standards;

(8) Pumping of leaking ponds into an enclosed container;

(9) Construction of interim or emergency ground water treatment systems;
(10) Posting of warning signs and fencing for a hazardous waste or substance site that meets legal requirements for protection of wildlife.
Authority cited: Section 21083, Public Resources Code; Reference: Section 21084, Public Resources Code.

Additionally, CEQA Guidelines section 15333 (Class 33), *Small Habitat Restoration Projects* consists of projects not to exceed five acres in size to assure the maintenance, restoration, enhancement, or protection of habitat for fish, plants, or wildlife provided that:
(a) There would be no significant adverse impact on endangered, rare or threatened species or their habitat pursuant to section 15065,
(b) There are no hazardous materials at or around the project site that may be disturbed or removed, and
(c) The project will not result in impacts that are significant when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects.
(d) Examples of small restoration projects may include, but are not limited to:
(1) revegetation of disturbed areas with native plant species;
(2) wetland restoration, the primary purpose of which is to improve conditions for waterfowl or other species that rely on wetland habitat;
(3) stream or river bank revegetation, the primary purpose of which is to improve habitat for amphibians or native fish;
(4) projects to restore or enhance habitat that are carried out principally with hand labor and not mechanized equipment.
(5) stream or river bank stabilization with native vegetation or other bioengineering techniques, the primary purpose of which is to reduce or eliminate erosion and sedimentation; and
(6) culvert replacement conducted in accordance with published guidelines of the Department of Fish and Game or NOAA Fisheries, the primary purpose of which is to improve habitat or reduce sedimentation.
Note: Authority cited: Section 21083, Public Resources Code; Reference: Section 21084, Public Resources Code

Therefore, many of the proposed compliance measures may be considered exempt from CEQA when project-specific analysis and evaluation of implementation actions are considered.

5.5 Environmental Checklist Project-Specific Information

The following section presents the project-specific information that is required as part of the Environmental Checklist.

- Project Title:
  Proposed *Amendment to the Water Quality Control Plan for the North Coast Region to Update Water Quality Objectives* (proposed WQO Update Amendment)

- Lead Agency Name and Address:
  North Coast Regional Water Quality Control Board
  5550 Skylane Blvd, Suite A
  Santa Rosa, CA 95403

- Contact Person and Phone Number:
  Jeremiah J. Puget, (707) 576-2220

- Project Location:
  The proposed WQO Update Amendment applies to the entire North Coast Region. See Section 2.1 of this Staff Report for more information on the North Coast Region.

- Description of the Project:
  The project is the proposed *Amendment to the Water Quality Control Plan for the North Coast Region to Update Water Quality Objectives*. See Section 5.1 of this Staff Report for a full description of the project.

5.5.1 Preliminary Staff Determination

☐	The proposed project COULD NOT have a significant effect on the environment, and, therefore, no alternatives or mitigation measures are proposed.
☑	The proposed project MAY have a significant or potentially significant effect on the environment, and therefore alternatives and mitigation measures have been evaluated.

5.5.2 Discussion of Environmental Checklist Findings

I. AESTHETICS -- Would the project:				
	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Have a substantial adverse effect on a scenic vista?			X	
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?		X		
c) Substantially degrade the existing visual character or quality of the site and its surroundings?		X		

d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?		X		

Aesthetics: a) Less than Significant
Discussion: If a spill or unauthorized release occurred within a scenic vista or resources, cleanup and remediation would occur in accordance with the existing regulations. The type of equipment needed as well as the duration of operation may be increased to comply with more protective criteria; however, this difference is negligible in aesthetic impacts.

Compliance measures such as planting trees and/or retaining trees are generally regarded as positive aesthetics. Scenic vistas usually include well-vegetated areas. In some cases the planting or retention of large woody vegetation could reduce visibility to an adjacent water body; however, vegetation also provides habitat for wildlife and in known to enhance water quality which would improve the overall landscape. Compliance measures such as riparian restoration, modifications to water supply and water storage practices in agricultural lands, and erosion and sediment control measures may modify the appearance of an area; however, these measures are not likely to result in the elimination of agricultural operations and elimination of open space. Therefore, impacts to scenic vistas are considered less than significant.

Aesthetics: b), c) and d) Less than Significant with Mitigation Incorporated
Discussion: While the existing regulatory requirements already result in a baseline condition that affects the aesthetic environment (i.e., groundwater cleanup and wastewater treatment laws and regulations), more protective criteria could result in the installation of additional equipment or storage of materials that decrease views or results in an unsightly presence for a longer period of time. Additionally, more stringent requirements could result in additional wastewater ponds and/or waste management/treatment units at existing facilities. Such incremental occurrences are not likely to result in a significant environmental impact.

Compliance measures such as the preservation of large woody vegetation generally have a positive impact on aesthetics. But, retention of large woody vegetation could lead to an increase fuel load for wildfires which could then impact scenic areas. Fire impacts on riparian zones vary proportionally with the severity and extent of burning in the catchment and are affected by stream size. Riparian zones can act as a buffer against fire and therefore as a refuge for fire-sensitive species. However, under some circumstances, such as dry pre-fire climatic conditions and the accumulation of dry fuel, riparian areas can become corridors for fire movement. Fire incursion into riparian zones creates canopy gaps and drier conditions, which allow subsequent buildup of dead wood and establishment of fire adapted species. In concert, this increases fuel loads and the probability of another fire. Secondary effects of riparian fire include altering nutrient fluxes and cycling, increasing sediment loads, and stimulating erosion. Riparian fires are potentially important in shaping ecological characteristics in many regions, but this is poorly quantified. A better understanding of riparian fire regimes is essential to assess the effects of fire in helping shape the complex ecological characteristics of riparian zones over the longer-term. (Pettit, N. E., and R. J. Naiman. 2007) Based on the evidence and nature of forest fires this appears to be a less than significant impact on the environment, if mitigated with proper fuel management. For example, the thinning of understory vegetation and select harvest prescriptions can decrease the fuel load while concurrently preserving and restoring shade along water courses. Additionally, firebreaks can be used in upland and riparian areas that do not affect water temperatures or sediment or nutrient mobility, so as to ensure strategic defense against wildfires.

A compliance measure that requires land disturbance, such as the construction of a settling basin or a riparian fence, may include minor surface soil excavation or grading during construction, which could result in increased disturbance of the soil. If, however, scenic resources were identified at the site, they would be avoided, and standard construction techniques and erosion and sediment control practices would require revegetation and would not result in permanent damage to scenic resources.

Neither the structural nor the non-structural compliance measures generally implemented as a result of this proposed policy would be expected to degrade the existing visual character or quality of a site and its surroundings, assuming application of appropriate mitigation measures. Although implementation of structural BMPs could result in some change in visual character or ground surface relief features, most of the compliance measures identified as part of the environmental analysis are of relatively small scale, such as installation of road drainage features, riparian planting, riparian fencing, small scale water diversion systems, wastewater treatment ponds, and reservoir or stream aeration structures. Likely, changes to the visual character or quality of the site and its surroundings will not be noticeable.

The larger scale projects, such as dam decommissioning, road decommissioning on USFS land, or construction of an off-stream water storage facility could potentially impact aesthetic resources. Visual impacts associated with dam decommissioning can be addressed through the decommissioning plan by including mitigation measures such as early establishment of native vegetation (grass, forbes and trees) on exposed surfaces. The construction of an off-stream storage facility (i.e., pond) could be expected to occasionally create a new source of substantial glare which could be mitigated with proper siting and vegetated screens.

Use of the mitigation measures discussed above can reduce the level of potential adverse impact to less than significant. Additional mitigation measures are detailed in Section 5.4.3 and Table 5-1.

II. AGRICULTURE AND FOREST RESOURCES:

In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Dept. of Conservation as an optional model to use in assessing impacts on agriculture and farmland. In determining whether impacts to forest resources, including timberland, are significant environmental effects, lead agencies may refer to information compiled by the California Department of Forestry and Fire Protection regarding the state's inventory of forest land, including the Forest and Range Assessment Project and the Forest Legacy Assessment Project; and forest carbon measurement methodology provided in Forest Protocols adopted by the California Air Resources Boards. Would the project:

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	X			
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	X			
C) Conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code section 12220(g)), timberland (as defined by Public Resources Code section 4526), or timberland zoned Timberland Production (as defined by Government Code section 51104(g))?				X
d) Result in the loss of forest land or conversion of forest land to non-forest use?				X
e) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to nonagricultural use or conversion of forest land to nonforest use?	X			

AGRICULTURE AND FOREST RESOURCES: a), b) and e) Potentially Significant and Unavoidable

Discussion: None of the potential compliance measures addressing groundwater toxicity or chemical constituents in groundwater or surface water would result in a conversion of agricultural or forested lands, conflict with existing agricultural uses, rezone forest lands, or results in the loss of forest lands. However, compliance measures to address controllable factors that affect DO may have potentially significant and unavoidable significant impacts by converting agricultural areas adjacent to waters of the state to non-agricultural uses.

Compliance measures such as riparian buffers could cause incidental loss of agricultural use in lands mapped as Prime Farmland, Unique Farmland or Farmland of Statewide Importance. These losses on a regionwide basis would only affect a very narrow band of land on either side of the watercourse, and as derived from the readily accessible information from the Farmland Mapping and Monitoring Program the U.S. Department of Agriculture National Agriculture Statistics Service, it is estimated that no more than 5% of the North Coast Region is mapped as Prime Farmland, Unique Farmland, and Farmland of Statewide Importance. Additionally, some areas that are mapped as prime, unique or important may comply already with the proposed WQO Update Amendment while others may not. Although there are many factors that affect this determination, it can be assumed that agricultural lands with a discharge of waste to waters of the state and that implement new riparian protection actions or compliance measures to address noncompliance with the DO objectives could be taking land out of production.

While avoidance and minimization measures can be used to lessen impacts, and experience suggests that some modified management of riparian zones is often appropriate, there is no mitigation for loss of land where that occurs. Therefore, this is a potentially significant and unavoidable impact. In some instances, the following mitigation measure may reduce the level of significance.
AGRMM-1: Coordination between project proponents, Regional Water Board staff and other local, state and federal agencies to achieve project-specific potential shade protections, nutrient load reductions, protection of areas of thermal refugia, and the preservation of agricultural lands.

AGRICULTURE AND FOREST RESOURCES: c) and d) No Impact
Discussion: No element of the proposed WQO Update Amendment will rezone or force the rezoning of Timberlands Production or result in the conversion of forested land to non-forested land. In short, the predominant, anticipated compliance measure for timberlands requires the retention of more forested area along streams and is consistent with the requirements of the recently adopted Temperature Implementation Policy. Therefore, this proposed policy has no impact on the classification of conversion of timberlands.

III. AIR QUALITY -- Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				
	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Conflict with or obstruct implementation of the applicable air quality plan?				X
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?		X		
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?		X		
d) Expose sensitive receptors to substantial pollutant concentrations?		X		
e) Create objectionable odors affecting a substantial number of people?			X	

Air Quality: a) No Impact
Discussion: The proposed WQO Update Amendment does not violate any clean air plans. Compliance measures intended to meet water quality objectives would not be permitted or forced to be implemented in a way that would conflict with an air quality management plan.

Air Quality: b), c), d) Less than Significant with Mitigation Incorporated
Discussion: Emissions from equipment used for construction, installation of facilities or treatment measures have the potential for temporary adverse effects to air quality. The primary pollutants of concern in these emissions are NOx or nitrogen oxides. Other emissions of concern could be carbon monoxide and PM_{10} (particulate matter < 10 microns). In order to evaluate the air quality impact of emissions due to compliance measures and associated equipment, the project proponent must identify the specific type of equipment that will be used in the remediation action. Next, emissions from the equipment must be quantified and evaluated in the context of air quality standards for the area in which the remediation is occurring, climate and meteorology, and time of year remediation will occur. A project scheduled in the winter may be less likely to cause exceedances of ozone standards than an action taken in the summer when ambient ozone levels are higher. This must be balanced with erosion-control measures which may preclude wet weather activity.

When evaluating the potential adverse effects to air quality, the project proponent must contact the appropriate regional air district for assistance in determining whether the amount of emissions generated at the remediation site will cause a violation of air standards. Project proponents will be responsible for meeting the requirements of the local air quality district for their specific project. If there is potential for an air quality violation, the project proponent must attempt to prevent or control emissions. This can be done by operating equipment under permit, purchase of air credits or offsets, use of electric equipment, planning the project for the time of year or day when emissions would be least likely to cause an exceedance of air quality standards, optimizing the mode of transportation, favoring disposal sites closer to the project sites, and minimizing the number of trips necessary to transport material to the disposal site or re-handling facility.

Compliance measures used to remediate soil and/or groundwater and to treat wastewater could result in the temporary generation of hydrogen sulfide, vinyl chloride, methane, ethane and ethene gases. The Bay Area Air Quality Management District (BAAQMD), which includes Sonoma County, has an air quality standard for hydrogen sulfide gas of 0.03 parts per million (ppm) or 42 $\mu g/m^3$ (1 hour average). The BAAQMD has an air quality standard of 0.010 ppm or 26 $\mu g/m^3$ (24-hour average), for vinyl chloride gas. Although select compliance measures may result in the generation of gases, it is unlikely. Other past projects using similar technologies within the jurisdiction of the Regional Water Board did not generate hydrogen sulfide or vinyl chloride gases.

The North Coast Unified Air Quality Management District (NCUAQMD), which includes Del Norte, Humboldt and Trinity Counties, is listed as "attainment" or “unclassified" for all the federal and state ambient air quality standards, except for the state 24-hour particulate (PM_{10}) standard. The District has not exceeded the federal annual standard for particulate matter during the last five year period. Primary sources of particulate matter in the Eureka area are on-road and off-road vehicles (engine exhaust and dust from paved and unpaved roads), open burning of vegetation (both residential and commercial), residential wood stoves, and stationary industrial sources (factories).

The entire North Coast Air Basin is currently designated as nonattainment for the State 24-hour PM_{10} standard. The attainment plans, rules and regulations, and criteria pollutant attainment status are different for each of the three air districts in the North Coast Air Basin.

Compliance measures that are intended to breakdown pollutants could result in the generation and emission of gases, but is unlikely. Several past projects using similar technologies within the jurisdiction of the Regional Water Board did not detect gases in ambient air. Additionally, thermal destruction incinerators or phytoremediation actions could produce off-gas, which themselves require treatment by an air pollution-control system to remove particulates and neutralize and remove acid gases (HCl, NO_x, and SO_x). If mitigation measures such as air quality monitoring plans and gas/particulate matter capture systems are added to the necessary compliance measures selected for use, these potential impacts to air quality will be less than significant. Additional mitigation measures are detailed in Section 5.4.3 and Table 5-1.

The compliance measures to address DO are anticipated to have a beneficial effect on the environment, greenhouse gas (GHG) emissions and climate change. Further, actions such as riparian preservation and restoration will sequester carbon from the atmosphere through plant photosynthesis. In addition, trapping soils through erosion and sediment control will reduce GHGs when carbon is locked up in trapped sediments, as well as living vegetation. Therefore, it is staff's judgment that the overall long-term benefits of the proposed WQO Update Amendment will aid in the reduction of GHGs and help provide resilience in the condition of North Coast watersheds and water resources as we face the uncertainty of climate change.

Compliance measures could result in the generation of fugitive dust and particulate matter during construction or maintenance activities, which could temporarily impact ambient air quality. Any such impacts would be temporary, and would be controlled with standard construction operations, such as the use of moisture to reduce the transfer of particulates and dust to air and conducting operations when the air quality in the basin is good (i.e. no catastrophic wildfires). The emissions of air pollutants during the construction of facilities for compliance are unlikely to have an effect on ambient air quality.

Implementation of compliance measures that require the use of heavy equipment (e.g., such as dam decommissioning, construction of settling basins, road drainage installation or re-contouring of existing road prisms), could result in vehicle emissions during construction. However, these impacts would be short-term, and would not result in conflicts with, or obstruction of the implementation of the applicable air quality plan. Air quality impacts associated with heavy equipment used to modify or remove on-stream or off-stream storage facilities or implement other structural compliance measures such as those could be potentially significant; but, they would be limited to those resulting from short-term construction activities. Compliance measures such as erosion control, reservoir reseeding and riparian planting are not likely to result in a violation of air quality standards.

Air Quality: e) Less than Significant Impact
Discussion: Subaqueous materials and sludge have the potential to create objectionable odors (e.g., hydrogen sulfide), and this is a potential adverse impact to air quality at the site where materials are removed, transported and disposed or reused. Whether the odor is considered to be significant is a function of the location of the site and whether a substantial number of people are affected. Reuse and disposal facilities must be located and designed to avoid generating nuisance odors that will adversely affect surrounding neighborhoods. It is unlikely that the proposed WQO Update Amendment will require new

facilities. Considering the existing baseline and the short duration and locations of these activities, the impacts are expected to be less than significant.

IV. BIOLOGICAL RESOURCES -- Would the project:				
	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?		X		
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?		X		
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?		X		
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?		X		
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?		X		
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?		X		

BIOLOGICAL RESOURCES: a), b), c), d), e) and f) Less than Significant with Mitigation Incorporated

Discussion: There are numerous Federal and State listed endangered and threatened animals which are known to be present, or have habitat they depend on in the North Coast Region. Such species could potentially be adversely impacted by measures implemented to comply with the proposed policy, if only temporarily. The location of sensitive species and habitat must be assessed on a project by project basis. Compliance measures to treat soil and/or groundwater and treat wastewater all have the potential to cause adverse effects to biological resources in several ways: short-term habitat destruction and displacement of sensitive species, possibly during critical periods such as nesting; disturbance of sensitive spawning or migrating fish species due to turbidity; and, "take" of endangered species.

With respect to site remediation, alternatives could occur in various types of habitats. Provisions of any cleanup plan are expected to result in the removal of pollutants that have adverse effects on plants and animals. This will improve habitat, and encourage development of and protect rare and endangered species, as well as fish and wildlife generally. There is a possibility that the quality of the environment could be temporarily degraded with potential effects on endangered species, if cleanup and mitigation projects are not carefully planned and executed. Potential adverse effects of identified remediation alternatives vary with different habitats, species, and time of year, as well as methods for remediating the site. Any potential adverse effects must be mitigated through consultation with the California Department of Fish and Wildlife (CDFW) and the U.S. Fish and Wildlife Service (USFWS). When installing structural compliance measures that involve substantial earth moving or riparian restoration activities that have the potential to affect candidate, sensitive, or special status species, project proponents are required to consult with federal, state and local agencies, including but not limited to the county, CDFW and the USFWS Project proponents must ensure project actions avoid, minimize and/or mitigate for impacts to rare, threatened or endangered species.

Riparian and wetland communities have been greatly reduced in size within California with wetland losses of up to 91 percent by estimation of the USFWS. Thus, such habitats within the region are very important to the many species they support. Special-status species are vulnerable to any habitat loss or degradation. The ability to move to other habitat through wildlife corridors is vital to many terrestrial species. Modification of existing terrestrial habitat in the project area, especially limited riparian and wetland habitat, would have the potential to cause adverse effects.

The expansion of remediation or treatment facilities may have a potential impact upon species identified as a candidate, sensitive, or special status species if they occur in an area where such species are located. While most facilities will not be sited in such locations spills and unauthorized releases along roads or highways that are adjacent to wetlands, rivers, and riparian areas give the potential. Additionally, many of the wastewater treatment plant facilities, reservoirs and areas of agriculture in the region are located near waterbodies with several sensitive and special status species. Expansion or installation of compliance measures in these areas could result in incremental adverse impacts to sensitive species habitats. The use of phytoremediation could result in bioaccumulation of toxic compounds if primary producing organisms became prey for threatened or endangered species. Reservoir or stream aeration structures have the potential to cause adverse effect on biological resources while being constructed, and could be improperly managed resulting in the supersaturation of the water column with oxygen which can stress or increase aquatic organism mortality. Additionally, a loss of wetland habitat from repair of leaky conveyance systems or alteration of irrigation practices has the potential to occur.

Stream restoration actions to reduce erosion, remove sediment, and improve habitat, or riparian restoration actions to increase shade, may conflict with the habitat requirements of certain flora or fauna. Specific examples include low lying flora that could be out competed in the riparian zone by taller, shade producing trees. In most cases, impacts could be avoided by adjusting the timing and/or location of the actions to take into account candidate, sensitive, or special status species or their habitats. Additionally, project-specific potential shade conditions are assessed and addressed on a case-by-case basis. Therefore, conflicts between the proposed compliance measures to address DO and particular species would be resolved at the project level. The process for designing, permitting, and implementing mitigation measures includes collaboration between water board staff and CDFW and USFWS staff to reach agreement on the most appropriate approach to protecting sensitive beneficial uses.

During project level construction activities to implement compliance measures, both structural and non-structural mitigation measures can be implemented to avoid, minimize or mitigate potentially significant impacts to sensitive species. Once a project plan is prepared and construction areas are delineated, measures must be implemented prior to and during construction to avoid and mitigate impacts to sensitive vegetation communities such as wetlands. For example, wetlands within 100 feet of any ground disturbance and construction-related activities (including staging and access roads) would be clearly marked and/or fenced to avoid impacts from construction equipment and vehicles. If new, temporary access roads are required, grading would be conducted such that existing hydrology would be maintained. In addition, water pollution control measures such as erosion control, sediment control, and waste management would be implemented to avoid and minimize potential water quality impacts from polluted storm water runoff to streams, wetlands and riparian areas.

Compliance measures to reduce erosion and sedimentation include rangeland planting and riparian restoration which has the potential to disturb soil and introduce non-native or invasive species. Mitigation measures to reduce these potential impacts include use of certified weed-free grass and project specific seed mixes to prevent the introduction or non-native on invasive species. Another example of avoidance or minimization includes work window restriction on stream restoration activities for the protection of several aquatic species. Additionally, aquatic ecosystem creation, restoration or enhancement projects are often designed to provide compensatory mitigation for impacts that cannot be avoided or minimized. Remedial action plans proposing phytoremediation would need to evaluate the potential for bioaccumulation of toxic compounds and select plants species that will not become primary producers in the food chain. Additionally, water quality monitoring may be a necessary to verify treatment and ensure no cross-media migration of pollutants.

While these impacts have the potential to occur, the likelihood of a significant adverse impact as a result of the proposed WQO Update Amendment it is unlikely. Nevertheless, measures to avoid impacts to biological resources (e.g., environmentally-sensitive area fencing and minimization measures like species-specific work windows) should be used to reduce potential impacts. All activities in federally-protected wetlands, except those statutorily exempt (e.g., agriculture), require the responsible party to obtain a Clean Water Act (CWA) Section 404 permit from the Army Corps of Engineers and a CWA Section 401 Water Quality Certification. These permits must include conditions that ensure that all water quality objectives for the wetland are protected. If a direct fill of a stream or wetland is absolutely necessary, then adequate compensatory mitigation in accordance with federal and state regulatory programs will be required to replace the loss of functions and values in compliance with the State's No Net Loss Policy[10].

Under CWA Section 404, the Corps issues permits to regulate discharges of dredged or fill material to waters of the United States. The CWA Section 404(b)(1) Guidelines are the environmental criteria used in evaluating discharges of dredged or fill material under CWA Section 404. Under the guidelines, the analysis of practicable alternatives is the primary screening mechanism to determine the necessity of permitting a discharge of dredged or fill material into regulated waters. The guidelines prohibit all discharges of dredged or fill material into regulated waters unless the discharge constitutes the least environmentally damaging practicable alternative that will achieve the basic project purpose.

The Corps must conduct a public interest review that weighs benefits versus detriments of the project and considers all relevant factors including: conservation, aesthetics, wetlands, flood hazards, flood plain values, navigation, recreation, water quality, safety, mineral needs, economics, general environmental concerns, cultural values, fish and wildlife values, land use, shoreline erosion and accretion, water supply and conservation, energy needs, food and fiber production, property ownership, and the needs and welfare of the public. The permit process must comply with National Environmental Policy Act (NEPA).

The Corps may also issue General Permits for discharges of dredged materials that have minimum adverse environmental effects (including cumulative effects). General Permits usually contain project-specific mitigation requirements. Nationwide Permits are issued by the Corps for specified types of projects that are limited in size and impacts. Section 404(b)(1) directs the U.S. EPA to develop guidelines for issuance of fill permits. The stated policy in these guidelines is that discharges of dredged or fill material into waters of the United States should not be conducted unless it can be proven that it will not have an

[10] Executive Order W-59-93

unacceptable adverse direct or cumulative impact. U.S. EPA may prohibit placement of fill if there will be an unacceptable adverse effect on: municipal water supplies, shellfish beds, fisheries, wildlife, or recreation areas. The guidelines provide that dredged or fill material shall not be permitted in a water of the United States if there is a practicable alternative that would have less impacts. For "Special Aquatic Sites" (wetlands, wildlife sanctuaries, mudflats, vegetated shallows, and riffle and pool complexes in streams), the guidelines presume that practicable alternatives are available and the permit applicant must provide otherwise.

CWA Section 401 allows states (Regional Water Boards and State Water Board) to deny or grant water quality certification for any activity which may result in a discharge to waters of the United States and which requires a Federal permit or license. Certification requires a finding by the State that the activities permitted will comply with all water quality standards individually or cumulatively over the term of the permit. Under Federal regulations (40 Code of Federal Regulations Section 131), water quality standards include the designated beneficial uses of the receiving water, the water quality criteria for those waters, and an antidegradation policy. Certification must be consistent with the requirements of the Federal CWA, the CEQA, the California Endangered Species Act (CESA), and the State Water Board mandate to protect beneficial uses of waters of the State. In order to certify a project, the state must certify that the proposed discharge will comply with all of the applicable requirements of CWA Sections 301, 302, 303, 306, and 307 (42 U.S.C. Sections 1311, 1312, 1313, 1316, and 1317).

Essentially, the Regional Water Board or State Water Board must find that there is reasonable assurance that the certified activity will not violate water quality standards. Water quality standards include water quality objectives and the beneficial uses of the receiving water, including all existing beneficial uses whether designated or not. CWA Section 401 requires the water quality certification process to comply with CWA Section 404(b)(1) Guidelines. CWA Section 401 allows the state to grant or deny water quality certification for any activity which may result in a discharge to navigable waters and which requires a federal permit. The Corps Section 404 permit is not valid if the State denies water quality certification.

California Fish and Game Code Section 1600 et seq. establishes a process to ensure that projects conducted in and around lakes, rivers or streams do not adversely impact fish and wildlife resources, or when adverse impacts cannot be avoided, ensures that adequate mitigation and or compensation is provided. Sections 1601 and 1603 of the Fish and Game Code are the primary sections with regard to developing Stream Bed Alteration Agreements. Projects that divert, obstruct or change the natural flow or bed, channel or bank of any river, stream, or lake where there is an existing fish or wildlife resource are subject to Section 1600. Fish and Game Code 1601 regulates the agreement process for projects proposed by state or local government agencies or public utilities while section

1603 regulates the process for projects proposed by all private project sponsors and federal projects without a state agency sponsor.

Any displaced habitats should be replaced nearby with equal or greater area and density, and restoration of the site or restoration of an offshore location should be required to mitigate for loss of any intertidal habitat.

Under the CESA, no person can "take" endangered or threatened species, except in cases where the CDFW issues an "incidental take" permit. Such a permit can only be issued if all of the following conditions are met:

- The take is incidental to an otherwise lawful activity.
- The impacts of the take are minimized and fully mitigated.
- The permit is consistent with any applicable Department regulations.
- The applicant ensures adequate funding to implement the mitigation measures and for monitoring compliance with, and effectiveness of, those measures.
- Permit issuance would not jeopardize the continued existence of the species.

Mitigation actions CDFW has typically required in association with incidental take authorizations and consultations have included:

- Protection of habitat of the affected species
- Establishment of an endowment to manage the protected habitat
- Provision of funds for enhancement of the protected land by fencing, initial trash cleanup, and related measures
- Implementation of various standardized construction avoidance measures
- Implementation of various standardized construction monitoring and reporting actions
- Implementation of other miscellaneous actions to reduce potential impacts; e.g., requiring that construction or operations employees be given orientation and training regarding the sensitive species, their habitats, and actions to be taken to minimize or avoid impact.

Based on the regulatory programs in place and variety of avoidance, minimization and mitigation measures available, the impacts to species, habitat, and federally protected waters from compliance measures to address chemical constituents and groundwater toxicity are less than significant with mitigation incorporated.

The majority of the North Coast Rivers and their tributaries provide habitat, including migration corridors, for both native resident and migratory fish. A migratory corridor is generally described as a landscape feature (such as a ridgeline, canyon, stream or riparian strip) within a larger natural habitat area that is used frequently by animals to facilitate movement and provide access to necessary resources such as water, food, or den, nesting or spawning sites. Wildlife corridors are generally an area of habitat, usually linear in nature, which connect two or more habitat patches that would otherwise be fragmented or isolated from one another. Most of the compliance measures will likely not interfere with the movement of these species. Although an activity such as dam removal would ultimately increase migration potential for aquatic organisms, significant adverse effects on aquatic species movement could occur at least temporarily, unless appropriate mitigation is implemented to limit the duration of impacts (e.g., temporary increases in turbidity). Any such activity should be timed to protect or reduce impact on the most sensitive species/life stages.

Compliance measures and BMPs such as riparian fencing (for cattle exclusion) and silt fence and straw wattles (for sediment control) have been known to entrap or entangle terrestrial wildlife (such as elk and deer), as well as some aquatic species (salamanders) and reptiles (snakes). Some specific areas are more prone to creating barriers to wildlife and can best be dealt with on a case-by-case basis. If there is a potential for an adverse impact to wildlife migration and/or use of a native wildlife nursery, the timing of the discharge and the location or the type of the compliance measure can be changed to avoid or minimize the impact to less than significant levels. For example, rotational grazing practices and hot wire fences are alternatives to exclusionary fencing, where exclusionary fencing has the potential to impede wildlife migration. Another option is to concentrate efforts on erosion control methods so as to avoid using silt fences in sensitive areas. Additionally, natural fiber straw waddles without plastic netting are available to use as alternatives to sediment control technologies that may be a migration barrier. Based on the project-specific situation, avoidance, minimization, and mitigation measures associated with a particular project, the potential impacts are less than significant with mitigation incorporated.

There is a potential for curtailments in surface water rights to meeting TMDL or other regulatory requirements in order to meet the objective for DO. Reductions in available water rights could results in the increased use of riparian water rights and groundwater. Therefore, as a result of the proposed Basin Plan Amendment, there could be an increase in riparian diversion of surface water and groundwater if water users choose to utilize riparian basis of right in addition to or in lieu of utilizing an appropriative water right. Increased riparian diversion could reduce surface water flows in the spring and summer, which are critical periods for fish habitat.

Although riparian water rights do not require the State Water Board's approval, the State Water Board has the authority to regulate riparian rights under the reasonable use doctrine. A particular water use or method of diversion may be determined to be unreasonable based on its impact on fish, wildlife, or other instream beneficial uses. (*Environmental Defense Fund, Inc. v. East Bay Municipal Utility District* (1980) 26 Cal.3d 183.)

The State Water Board also has an affirmative duty to take the public trust into account in the planning and allocation of water resources. The purpose of the public trust doctrine is to protect navigation, fishing, recreation, environmental values, and fish and wildlife habitat. (*National Audubon Society v. Superior Court* (1983) 33 Cal.3d 419, 434-435.) Under the public trust doctrine, the State retains supervisory control over the navigable waters of the state and the lands underlying those waters. (*Id*. at p. 445.) In applying the public trust doctrine, the State Water Board has the power to reconsider past water allocations even if the State Water Board considered public trust impacts in its original water allocation decision. Thus, the State Water Board may exercise its authority under the doctrines of reasonable use and the public trust to address reduced instream flows in the policy area and adverse effects to fish, wildlife, or other instream beneficial uses due to riparian diversions. Based on the range of possible mitigation measures, these potential impacts are considered less than significant with mitigation incorporated.

Compliance measures do have the potential to conflict with ordinances protecting biological resources, such as a local tree preservation policy, or an endangered species near a wastewater treatment plant outfall. It is unlikely that the implementation of compliance measures would conflict with the provisions of an adopted Habitat Conservation Plan (HCP), Natural Community Conservation Plan (NCCP) or other approved local, regional, or state habitat conservation plan. However, it is possible that a wastewater facility expansions or unauthorized discharges or spills could result in a remedial action. Compliance measures that encourage riparian protection, treat wastewater and remediate contaminated soil and groundwater are not expected to conflict with ordinances protecting biological resources, but do have the potential to impact threatened or endangered species in the region.

It could be possible that a low lying special status species with an associated conservation plan could be present in the riparian zone that could accommodate larger trees to produce shade. However, the larger shade producing vegetation may out compete or adversely affect that special status species. These instances are likely sparse and since compliance measures are to be implemented case-by-case these types of discrepancies can be handled at the project or permit level through agency collaboration and so as to prevent significant impact on the environment. Additionally, compliance measures leading to an expansion of soil and groundwater remedial or wastewater treatment facilities could occur within areas with existing HCPs or NCCPs; however, these measures are focused on improving habitat and reducing toxicity that may adversely affect biological resources. While the likelihood of such impacts remains low the presence of threatened and endangered species does create a potential for impact. Therefore, less than significant with mitigation is the appropriate finding. A summary of potential impacts to biological resources and mitigation measures are presented in Section 5.4.3 and Table 5-1.

V. CULTURAL RESOURCES -- Would the project:				
	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Cause a substantial adverse change in the significance of a historical resource as defined in § 15064.5?		X		
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to § 15064.5?		X		
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?			X	
d) Disturb any human remains, including those interred outside of formal cemeteries?		X		

CULTURAL RESOURCES: a), b) and d) Less than Significant with Mitigation Incorporated

Discussion: It is unlikely that the majority of compliance measures would cause a substantial adverse change in the significance of a historical or archaeological resource pursuant to section 15064.5. The implementation of compliance measures as recommended under the proposed WQO Update Amendment would not result in the alteration of a significant historical or archaeological resource. However, in cases where the installation or expansion of compliance measures may involve large scale excavations or earth disturbing activities, a cultural resources investigation should be conducted before any substantial disturbance. The cultural resources investigation will include, at a minimum, a records search for previously identified cultural resources and previously conducted cultural resources investigations of the project parcel and vicinity. All future actions must comply with the CEQA process and requirements for tribal consultation provided by Senate Bill 18 (SB 18) (State 2004, Ch 905) and Government Code section 65252.

In the event that avoidance is infeasible, the future projects will be required to follow Native American Heritage Commission's mandate for Native American Human Burials and Skeletal Remains, in partnership with affected tribe(s), in order to adequately provide for recovering scientifically consequential information for the site. In the event that the ground disturbances uncover previously undiscovered or documented resources, California law protects Native American burials, skeletal remains, and associated grave goods regardless of the antiquity and provides for the sensitive treatment and disposition of those remains. (Health & Safety Code, Section 7050.5; Public Resource Code, Section 5097.9 et seq) This record search should also include, at a minimum, contacting the appropriate information center of the California Historical Resources Information System, operated under the auspices of the California Office of Historic Preservation. In coordination with the information center or a qualified archaeologist, a determination regarding whether previously identified cultural resources will be affected by the proposed project must be made and if previously conducted investigations were performed to satisfy the requirements of CEQA. If not, a cultural resources survey would need to be conducted. The purpose of this investigation would be to identify resources before they are affected by a proposed project and avoid the impact. If resources are identified, project-specific implementation will minimize impacts. Additional mitigation measures are detailed in Section 5.4.3 and Table 5-1.

CULTURAL RESOURCES: c) Less than Significant
Discussion: The implementation of compliance measures is not likely to directly or indirectly destroy a unique paleontological resource or site or unique geologic feature. Similarly, it is unlikely that implementation of any compliance measure would result in the destruction of a unique paleontological resource or site or unique geologic feature. However, in cases that involve excavation activities, an investigation of paleontological resources would need to be conducted by a trained professional before any substantial disturbance of land that has not been disturbed previously.

VI. GEOLOGY AND SOILS -- Would the project:				
	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.				X
ii) Strong seismic ground shaking?				X
iii) Seismic-related ground failure, including liquefaction?				X
iv) Landslides?		X		
b) Result in substantial soil erosion or the loss of topsoil?		X		
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or offsite landslide, lateral spreading, subsidence, liquefaction or collapse?		X		

d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?				X
e) Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?		X		

GEOLOGY AND SOILS: a) (i, ii, and iii), and d) No Impact
Discussion: None of the compliance measures would result in any adverse impact related to fault zones, liquefaction or other seismic related activity. Nor would it result in any lateral spreading, subsidence, liquefaction, or collapse. Even if structural BMPs that were recommended were located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), they would not create substantial risks to life or property. The structural BMPs that have been identified as the foreseeable means of compliance do not involve moving permanent structures or people into a new area, and so there would be no risk to life or property created.

GEOLOGY AND SOILS: a) (iv), b), c) and e) Less than Significant Impact with Mitigation Incorporated
Discussion: Compliance measures do not change the exposure of people or structures to potential substantial adverse effects involving landslides over current conditions. The geographic scope of the activities covered under the proposed WQO Update Amendment will include areas that are highly susceptible to soil erosion and shallow landslides due to the presence of steep slopes, high rainfall rates, and/or underlying geology. A major focus of the sediment control actions discussed here and in existing regulation are designed to ensure proper road drainage, surface soil stability, avoidance of unstable areas, and full vegetation potential which reduces soil erosion, and can reduce or prevent large-scale slope and fill failures.

Implementation of compliance measures such as wells, ponds, trenches, aquatic ecosystems restoration, erosion and sediment controls and other facility expansions that involve construction may result in temporary ground disturbances. Soil excavations, compost operations or land farming could result in erosion and sedimentation. However, construction related erosion impacts should cease with the cessation of construction activities. Standard best management practices (BMPs) to address erosion, sediment, and pollution prevention should be used on cleanup or waste treatment sites.

Facility pollution prevention plans should be developed to ensure that the correct BMPs are selected during installation of remedial actions and for the operation of such facilities or treatment measures. For example excavated material if stockpiled should be covered prior to precipitation to avoid contaminating storm water runoff. Additionally, if a large facility expansion is necessary, the development of a storm water pollution prevention plan

(SWPPP) may be required. For construction activities that are greater than one acre, the development enrollment under the NPDES construction storm water permit will be required. Based on the existing regulatory conditions and existing BMPs available, this proposed Basin Plan amendment is not likely to have an adverse effect on soil erosion or loss of topsoil. Therefore, the impact is less than significant with mitigation incorporated.

Compliance measures like excavation and trenching create the potential to encounter expansive soils, soil collapse, and structures. However, compliance measures implemented at a project site requires site a specific work plan and health and safety plan to be developed by a licensed geologist or engineer prior to implementation. Such plans ensure conditions are assessed and impacts appropriately avoided prior to initiation of the project. Onsite staff will be made aware of potential risks and management measures associated with any structures, soil instability, expansive soils, or other features associated with the unique nature of the project setting, with specific attention to potential risks to life or property and appropriate protections.

Compliance measure to address nutrients, chemical constituents and groundwater toxicity may result in addressing septic tanks or alternative wastewater treatment systems. However, the development of project-specific remedial action plans or wastewater treatment system design must take site-specific characteristics into account and ensure regulatory approval. The mitigation measures discussed above, in Section 5.4.3 and Table 5-1, are existing regulatory requirements and can be applied in many different settings to mitigate potential adverse impacts to soils and geology.

VII. GREENHOUSE GAS EMISSIONS – Would the project:				
	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Generate Greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?			X	
b) Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of greenhouse gases?			X	

GREENHOUSE GAS EMISSIONS: a) and b) Less than Significant

Discussion: Adoption of the policy itself will not cause a direct impact to greenhouse gases (GHGs). Implementation of the compliance measures at the project level could result in an increase risk or contribution to greenhouse gases related to exhaust from equipment and vehicles used during construction activities, such as restoration and alternate water supply construction. In most cases, the potential adverse impacts stem from minor facility alterations and improvements or extended operation and maintenance of wastewater treatment or groundwater remediation facilities, as compared to the current baseline. This incremental increase in emissions is not likely to cause an adverse effect.

Furthermore, any remediation or treatment projects must be consistent with the State Water Board Resolution No. 2008-0030 which directs Water Board staffs to "require…climate change considerations, in all future policies, guidelines, and regulatory actions." Also, the proposed WQO Update Amendment is intended to be implemented in a manner which conforms with the goals of Assembly Bill (AB) 32 (States, 2005, ch 488). AB 32 requires that GHG emissions be reduced to 1990 levels by 2020. This requirement relates to anthropogenic sources of GHGs. Impacts associated with individual projects implemented under this policy, will be analyzed for their potential to increase GHGs, and appropriate mitigation implemented to reduce that potential. Finally, implementation of compliance measures which serve to sequester nutrients, retain soils on the landscape, and increase biomass, also generally serve to sequester GHGs thus having a net positive impact.

Climate change is likely to create increased groundwater pumping due to reduced surface water flows during summer months. As extraction pressures on groundwater basins increase, there may be increased attempts to remediate contaminated aquifers. Developing additional groundwater supplies through remediation will increase California's ability to provide water supplies during drought periods. Making more groundwater basins available for water storage also allows for augmentation of groundwater supplies with recycled or desalinated water. Some of the treatment technologies used for groundwater remediation are energy intensive and may result in increased GHG emissions above the existing baseline. However, the restoration and protection of groundwater basins promote local sustainability and reliable yield; which may facilitate less energy intensive water imports and complicated infrastructure, ultimately leading to reduced GHG emissions. Therefore, the potential for an increase in GHG emissions is less than significant.

VIII. HAZARDS AND HAZARDOUS MATERIALS -- Would the project:				
	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?		X		
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the		X		

environment?				
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?		X		
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?		X		
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?		X		
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?		X		
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?				X
h) Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?		X		

HAZARDS AND HAZARDOUS MATERIALS: a), b), c) d), e), f), and h) Less than Significant with Mitigation Incorporated

Discussion: The existing regulatory baseline includes numerous federal, state and local laws regarding the designation, handling, transportation and disposal of hazardous substance. Nothing in the proposed WQO Update Amendment alters this existing regulatory baseline. However, the manner in which hazardous materials are handled and controlled, can have environmental impacts appropriate highlighted here.

Specifically, in any action involving chemicals or toxic pollutants, there is a potential for release of pollutants due to an accident or upset condition. The potential for such releases can be greatly reduced by proper planning. Measures to prevent releases of toxic pollutants include such things as pollution prevention technology (e.g., automatic sensors and shut-off valves, pressure and vacuum relief valves, secondary containment, air pollution control devices, double walled tanks and piping), access restrictions, fire controls, emergency power supplies, contingency planning for potential spills and releases, pollution prevention training and other types of mitigation appropriate to the cleanup plan. Remedial action plans should and do consider site geology, hydrology, surrounding land uses and potential receptors, costs, and air quality control plans (including monitoring and contingency plans) if necessary.

Fuels, lubricating oils, and other petroleum products will be used during cleanup activity. Well established techniques for controlling spills, leaks, and drips should be incorporated in work plans, remedial action plans, treatment plans and site health and safety plans to assure the control of petroleum products and any other chemicals used during the cleanup activity. In order to mitigate the potential adverse effects, pollution prevention plans and waste management BMPs should be used in conjunction with the implementation of compliance measures.

Existing regulations require the proper storage, handling and use of these types of materials. In the event of an accident, responsible parties must comply with the requirements of the California Emergency Management Agency Hazardous Materials Spill reporting process. Any significant release or threatened release of a hazardous material requires immediate reporting by the responsible person to the Cal EMA State Warning Center (800) 852-7550 and the Certified Unified Program Agency (CUPA) or 911.
The CUPA may designate a call to 911 as meeting the requirement to call them. Contact information for a jurisdiction's CUPA can be found at
http://cersapps.calepa.ca.gov/Public/Directory/ or
http://cersapps.calepa.ca.gov/Public/UPAListing.
Notifying the State Warning Center (800) 852-7550 and the CUPA or 911 constitutes compliance with the requirements of section 11004 of title 42 of the United States Code regarding verbal notification of the SERC and LEPC (California Code of Regulations, Title 19 Section 2703 (e)). Additional information regarding spill reporting may be found at
http://www.calema.ca.gov/HazardousMaterials/Pages/Spill-Release-Reporting.aspx

Road repair and maintenance can involve the transport and use of materials that would qualify as hazardous pursuant to the California Health and Safety Code section 25501(o). There is the possibility that hazardous materials may be transported to a site and be present during compliance measure construction, installation and maintenance activities. These materials include gasoline and diesel to fuel equipment, hydraulic fluid associated with equipment operations and machinery, asphalt and oils for road surfacing, and surface stabilizers (e.g. lignin) for running surfaces on unimproved roads. Maintenance yards house fuel, oil (machine, hydraulic, crankcase), chemicals (acids, solvents & degreasers, corrosives, antifreeze), hazardous waste, heavy metals, nutrients, fertilizer, pesticides, herbicides, paint products, and sediments. Maintenance yard activities have the potential to discharge these materials to storm water drain systems or watercourses. Some BMPs specifically target proper storage of these types of materials. Dust palliatives and de-icing agents may be used in some instances; but, these materials properly applied according to BMPs are not considered hazardous materials. Compliance measures would have the potential for a significant hazard to the public or the environment through the routine transport, use or disposal of hazardous materials.

In order to mitigate the potential adverse effects, pollution prevention and waste management BMPs should be used in the implementation of compliance measures. Existing regulations require the proper storage, handling and use of these types of materials. The U.S. Forest Service, California Department of Transportation, Five Counties Salmonid Conservation Program in the Counties of Del Norte, Humboldt, Mendocino, Siskiyou, and Trinity in the North Coast Region, California Association of Storm Water Quality, are just a few of the examples of exiting manuals that provide numerous pollution prevention and waste management BMPs. Many of these manuals include measures to be taken in the event of a spill.

Retention of large woody vegetation could lead to an increase fuel load for wildfires which could then impact scenic areas. Fire impacts on riparian zones vary proportionally with the severity and extent of burning in the catchment and are affected by stream size. Riparian zones can act as a buffer against fire and therefore as a refuge for fire-sensitive species. However, under some circumstances, such as dry pre-fire climatic conditions and the accumulation of dry fuel, riparian areas can become corridors for fire movement. Based on the evidence and nature of forest fires this appears to be a less than significant impact on the environment, if mitigated with proper fuel management. For example, the thinning of understory vegetation and select harvest prescriptions can decrease the fuel load while concurrently preserving and restoring shade along water courses. Additionally, firebreaks can be used in upland and riparian areas that do not affect water temperatures or sediment or nutrient mobility, so as to ensure strategic defense against wildfires.

The mitigation measures discussed above and identified in Section 5.4.3 and Table 5-1 will likely reduce the level of impacts to less than significant.

HAZARDS AND HAZARDOUS MATERIALS: g) No Impact
Discussion: The proposed WQO Update Amendment will not result in compliance measures that will impair or hinder any emergency response plans.

IX. HYDROLOGY AND WATER QUALITY -- Would the project:				
	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Violate any water quality standards or waste discharge requirements?	X			
b) Substantially deplete groundwater supplies				

or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?	X			
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or offsite?		X		
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or offsite?		X		
e) Create or contribute runoff water which would exceed the capacity of existing or planned storm water drainage systems or provide substantial additional sources of polluted runoff?		X		
f) Otherwise substantially degrade water quality?		X		
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?				X
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?		X		
i) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?		X		
j) Inundation by seiche, tsunami, or mudflow?				X

HYDROLOGY AND WATER QUALITY: a) Potentially Significant and Unavoidable
Discussion: Water quality standards consist of the water quality objectives, the beneficial uses of water and the antidegradation policy. For the State's purposes, it also includes the implementation and monitoring plans. [11] The proposed WQO Update Amendment is to revise the water quality objectives for chemical constituents and DO and add a new objective for groundwater toxicity. The addition of a new toxicity objective will not necessarily create a new set of violations that would not have been previously defined as

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such. The state antidegradation policy (Res. No. 68-16) already requires preservation of the best water quality conditions since 1968 where those conditions are better than water quality objectives. Similarly, Resolution No. 92-49 establishes natural background conditions as the cleanup level in cases where it is economically and technologically feasible.

Land application of wastewater could result in groundwater quality impacts through the accumulation of organics, salts, or precipitation of naturally occurring metals in soils. While the fate and transport of pollutants of concern is best understood incorporating site-specific conditions, there is a reasonable and general understanding of how typical pollutants migrate to and through receiving waters. To mitigate this potentially adverse impact, water quality monitoring can be conducted to detect increases in concentrations for constituents of concern, and prevent any additional degradation. A recently published court decision interpreting the application of state antidegradation policy (*Association de Gente Unida por el Agua V Central Valley Regional Water Quality Control Board, (2012) 210 Cal. App.4th 1255 (AGUA)* and gave precedential effect to State Water Board guidance on the application of Resolution 68-16.

Regarding DO, by requiring the implementation of compliance measures that preserve and maintain shade, control sediment, and maintain stream flows supportive of beneficial uses, there will be an overall beneficial impact on water quality in the North Coast Region. The operation of aeration systems for DO have the potential to supersaturate the water column, exceed water quality standards, and lead to accelerated mortality rates of salmonids and other sensitive aquatic organisms. However, this impact can be mitigated by proper design, operation and maintenance, as well as conducting the proper water quality monitoring when implementing structural compliance measures intended to raise levels of DO.

There are special circumstances, however, under which potential significant impacts could occur. For example, the primary environmental impact associated with dam removal or large scale aquatic ecosystem restoration in the short-term (months to years) could result in the discharge of sediments or construction materials that could impact water quality with temporary increases in turbidity, suspended sediment load, organic matter, or remobilization of chemical constituents from contaminated sediments with consequences on dissolved oxygen, water column concentrations of chemical constituents, or toxicity. Such discharges could result in the exceedance of the proposed Basin Plan water quality objectives for DO or chemical constituents in surface water. Short-term water quality exceedances may be acceptable in cases where long-term benefits to be beneficial uses outweigh short-term impacts, based on detailed, site-specific information and findings. However, in the context of the CEQA, such an activity could result in significant and unavoidable impacts to water quality.

HYDROLOGY AND WATER QUALITY: b) Potentially Significant and Unavoidable
Discussion: Remediation efforts that use pump and treat systems can alter the water table. In some cases, the manipulation conducted intentionally so as to prevent pollutant migration. However, each system is installed after the preparation of a remedial action plan which evaluates site characteristics such a soil permeability and transitivity to evaluate the potential for adequate yield. At the point which remedial actions are near approval, most, if not all potential impacts to receptors (such as through drinking water wells, basements, and surface waters) have been identified, located, and assessed for threat of contamination. When pumping and treating is an optional treatment method, pilot tests are performed to confirm the estimated effects of drawdown. If negative affects to water supply wells are noted, it is unlikely the proposed action will be approved for full-scale operation. Operations in such circumstances may only be conducted if the nearby supply wells are in eminent danger of contamination and hydraulic control is necessary. In these cases, the water supply use would already be impacted and the compliance measures would be conducted to support a usable well. Therefore, the impact to water supply wells from soil and groundwater remedial actions is less than significant.

Regarding DO, the alteration of the natural pattern and range of surface water flows as a controllable factor with respect to ambient water temperatures and DO could result in some project proponents seeking alternative water sources. In addition, surface water supplies may be insufficient to meet all future demands, even in the absence of the proposed Basin Plan amendment. Surface water resources are already limited in some areas of the North Coast Region. In those areas, future water supplies will be limited by the natural supply availability rather than restrictions on water diversion and storage. Some streams in the region are already fully appropriated for some or all of the year.

Pumping groundwater instead of diverting surface water could potentially deplete groundwater resources, which could potentially result in a reduction in surface water flows, particularly summer flows, which could affect surface water flows. Additionally, increases in riparian vegetation can in turn lead to increased levels of evapotranspiration thereby reducing stream flows. Reduced surface water flow could potentially harm riparian vegetation or degrade habitat for sensitive species; could potentially adversely affect water temperature and increase constituent concentrations due to reduced dilution; and could potentially adversely affect recreational opportunities. However, these compliance measure are likely reduced to levels less than significant in many cases with the implementation of mitigation measures such planting native vegetation, allowing for thinning of upland vegetation to reduce evapotranspiration, conducting monitoring, and modeling surface water flow rates in conjunction with groundwater extraction as detailed in Section 5.4.3 and Table 5-1.

Depending on the circumstances, switching from surface water diversions to groundwater pumping or diverting water under riparian rights could have a significant adverse impact on biological resources, water quality, or recreation. As discussed below, however, the possible effects of a user switching from a surface water diversion to a ground water diversion are dependent on a wide range of variables, and therefore it is highly uncertain whether any particular user who may switch to groundwater will cause a delay in surface water flow depletion, whether any such delay will cause a significant reduction in surface water flows, or whether any delayed reduction in flows will have a significant adverse impact on the environment, including DO concentrations.

Surface water flow depletion may continue after groundwater pumping stops because it takes time for groundwater levels to recover from the previous pumping stress and for the depleted aquifer defined by the cone of depression to be recharged with water. Therefore, the time of maximum stream depletion may occur after pumping has stopped. Eventually, the aquifer and stream may return to their pre-pumping conditions. But, the time required for full recovery may be quite long and exceed the total time that the well was pumped. Any time delay may range from a few days in the zone adjacent to the stream to thousands of years for water that moves from the central part of some recharge areas through deeper parts of the groundwater system (Heath, 1983).

The level of significance for a potential impact to hydrology/watery quality attributable to a delay in surface water flow depletion as a result of diverters switching to groundwater pumping or riparian rights, is dependent on site-specific circumstances. In light of the fact that the switch to groundwater or riparian diversions as alternative sources of supply is possible, the potential impacts to hydrology and water quality are identified as significant and unavoidable.

HYDROLOGY AND WATER QUALITY: c), d) and e) Less than Significant with Mitigation Incorporated

Discussion: Placement of physical structures, such as reactive barriers or physical barriers, are intended to alter groundwater hydrology, but these measures are typically used to treat, remediate and protect contamination from reaching potential receptors. Using caps to protect sites has the potential to alter hydrology depending on the nature of the cap design and local precipitation patterns. Some caps are made of impervious materials such as asphalt, concrete, or certain types of membranes. Impervious surfaces decrease the amount of precipitation which is infiltrated by native or uncapped soils. This leads to increased runoff at higher volumes and velocities and can negatively alter streams, causing flooding, erosion, incision and stream degradation. The type, size, and location of caps should be considered in the remedial action or treatment plans. The hydrologic effect of caps should be evaluated in proposed plans and in future project level CEQA analyses.

Wastewater treatment system facilities and groundwater pump and treat systems may move or discharge large volumes of water that could potentially contribute to alterations of hydrology. But, existing Basin Plan discharge prohibitions, as well as the existing NPDES and WDR permit programs address discharge flows for potential adverse effects on water quality and hydrology, and therefore are not likely to contribute to adverse effects.

If a cap is ultimately necessary to protect groundwater, then it must be constructed in a manner that considers site hydrology. For example, BMPs such as bioswales and detention ponds can be designed into a project proposal to reduce peak flow and peak volume storm water discharge rates. Spills, leaks or discharges from the construction of compliance measures could directly affect water quality and indirectly affect waters by polluting storm water runoff. These potential impacts should be addressed in a facility's remedial action plan, treatment plan or storm water pollution prevent plan. Based on the existing requirements to evaluate site-specific hydrology from such proposals, the potentially adverse effects can be mitigated though additional storm water controls.

Infiltration basins, field leveling, road construction, bioengineering, and in-stream restoration are all activities which could potentially cause an alteration of the existing drainage pattern of a site. In most cases however, these compliance measures would be installed with appropriately designed mitigation measures so as to limit any alteration of the existing drainage pattern, unless beneficial to the environment. In general, such compliance measures could be installed without resulting in substantial erosion of siltation on- or offsite. For example, scheduling, straw, seed, silt fence, straw waddle, straw bales, drip protection, vehicle cleaning and maintenance, and site inspections are all methods that can be employed. Permittees are commonly required to install and maintain erosion control measures (e.g. waterbars, rolling dips, mulch, rock rip-rap) to prevent discharge of excess sediment from soil disturbing activities. Similarly, a common requirement is to relocate roads away from unstable and landslide-prone terrain. Roads must be drained away from unstable areas during construction, reconstruction of maintenance activities. New roads must be located on stable ground, to the maximum extent practicable. Other common requirements are to: minimize cut-bank height, avoid placement of fill on steep slopes, use off-channel water collection features for dust abatement purposes, and install adequate number/type of road drainage features to prevent concentration of road runoff. Permittees are always advised to seek professional help (e.g. Natural Resources Conservation Service, local resource conservation district) in developing land management plans and employing observational techniques to ensure optimal stocking rates for rangelands, for example.

HYDROLOGY and WATER QUALITY: f) Less than Significant with Mitigation Incorporated

Discussion: The addition of reducing agents to breakdown contaminates can often and temporarily lead to an increase in more toxic compounds. During the reductive de-chlorination process, metals such as arsenic, manganese, and antimony, may be mobilized in the subsurface. Additionally, the chemical tetrachloroethlyene (PCE), can breakdown to trichloroethylene (TCE), cis-1,2-Dichloroethelene (cis-1,2-DCE) and vinyl chloride (VC). The use of zone injections has also been known to temporarily transform chromium III into the more toxic chromium VI (Cr VI). Although the parent compounds breakdown to the more toxic intermediary VC and Cr VI, this is temporary and the degradation will continue to occur with further breakdown to non-toxic end products (e.g., carbon dioxide, chloride, Cr III and water). Through the existing regulatory programs, the responsible parties shall comply with monitoring and reporting program orders that contain requirements for groundwater monitoring to evaluate the mobilization of metals and VOCs, and verify the return of pre-treatment water quality conditions minus the groundwater contaminants. Adding reducing agents to groundwater is designed to reduce groundwater toxicity and enhance cleanup of the aquifer. Through proper implementation of remedial actions and careful groundwater monitoring and reporting these potential impacts are less than significant with mitigation incorporated. Additional mitigation measures to reduce impacts to water quality are detailed in Section 5.4.3 and Table 5-1.

HYDROLOGY AND WATER QUALITY: h) and i) Less than Significant with Mitigation Incorporated

Discussion: It is possible that compliance with the proposed WQO Update Amendment could place structures within a 100-year flood hazard area which could impede or redirect flood flows. For example, switching from an in-stream diversion to off-stream water storage site could result in a structure being placed within the flood plain. Additionally, aquatic ecosystem restoration that calls for the breaching lakeshore levees or reservoirs to create diverse habitat features and lower lake levees to create riparian fringe habitat has the potential to adversely affect hydrology and natural flow patterns as well as potentially expose people or structures to flooding. However, it is in these instances that coordination with project proponents and other agencies is best suited to reduce potentially significant impacts.

These types of actions should be analyzed individually under CEQA, on a project by project basis. Such projects should be implemented in a manner so as to avoid, minimize or mitigate potential significant impacts. As presented in section 5.4.3, mitigation measures include proper design, siting, and operational timing to reduce alterations of natural hydrology and adverse effects. Additional mitigation measures include monitoring and modeling flows and proper hydrology to minimize potential adverse effect prior to project implementation. Although there is a possibility that these types of compliance measures could cause an adverse impact, any potentially significant impacts will be avoided or mitigated to less than significant with mitigation incorporated. Additional mitigation measures to reduce impacts to water quality are detailed in Section 5.4.3 and Table 5-1.

HYDROLOGY and WATER QUALITY: g) and j) No Impact

Discussion: None of the proposed compliance measures would result in the placement of housing in a flood plain or tsunami zone, and therefore would not have an adverse impact due to; redirection of flows, floods, dams or levee breaches or that may result in injury or death.

X. LAND USE AND PLANNING - Would the project:				
	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Physically divide an established community?				X
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?		X		
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?		X		

LAND USE AND PLANNING: a) No Impact
Discussion: None of the compliance measures identified in this Staff Report contemplate the use of non-structural or structural BMPs that would physically divide an established community.

LAND USE AND PLANNING: b) Less than Significant with Mitigation Incorporated
Discussion: In 1992, the state legislature provided an opportunity for more formal groundwater management with the passage of AB 3030[12]. In 2002, SB 1928 was signed into law requiring any public agency seeking state funds administered through Department of Water Resources (DWR) for construction of groundwater projects to prepare and implement groundwater management plans with certain specified components. These plans brought a number of agencies into the groundwater management arena promoting a non-regulatory approach and local oversight. Many cities and counties in the state are involved in groundwater management through the development and implementation of local ordinances or plans designed to address water supply issues. Groundwater management plans under SB 1928 are intended to consider management objectives, protection of water quality, groundwater recharge potential, water conservation, low impact development, and other issues associated with sustainable groundwater use. In the North Coast Region a few municipalities and key stakeholder groups have developed voluntary groundwater management plans in the following locations: the Lower Mad River Area; the Mendocino City Community Service District; Scott Valley; Tule Lake Irrigation District; and the Santa Rosa Plain. In addition, several of the implmenting municipalities are assessing their water supplies, including consideration of groundwater availability.

[12] water code § 10750

An existing method used throughout the state to manage water resources is known as aquifer storage and recovery (ASR). This method uses various techniques (e.g., from infiltration to injection) to actively recharge groundwater aquifers during the wet season for storage and later use in the dry season. For example several local municipalities in the Santa Rosa Plain groundwater basin throughout the region have begun investigating the use of ASR as a tool to help balance water supply needs during the dry season when surface water withdrawls from the Russian River are restricted so as to accommodate the flow needs of threatened and endangered species. There are many ways to implement ASR projects; however, one method currently under consideration includes the injection of potable water through municipal water wells into the underlying aquifer. This method includes the injection of disinfected, potable drinking water into an aquifer for storage, later recapture, treatment and then distribution.

In 2012, the State Water Board adopted Water Quality Order No. 2012-0010 *General Waste Discharge Requirement for Aquifer Storage and Recovery Projects That Inject Drinking Water into Groundwater (*ASR WDR*)*. This Order authorized the discharge of drinking water that has been treated pursuant to the California Department of Public Health (CDPH), now the State Water Board Division of Drinking Water (DDW), domestic water supply permit, which requires disinfection and the maintenance of disinfection by-products in public water supply systems used to eliminate pathogens. However, disinfection by-products such as trihalomethanes, haloacetic acids, bromate, and chlorite can be present in water supplies which are known to have adverse health effects at certain concentrations. This requirement illustrates the balance between known biological (pathogens) and chemical (disinfectants) effects on human health; which the DDW is responsible for overseeing. Additionally, injection of treated drinking water into an aquifer may induce geochemical reactions, some of which may cause exceedance of a water quality objective. For example, the introduction of treated drinking water with a higher concentration of dissolved oxygen into an anaerobic aquifer may induce geochemical oxidation-reduction (or “redox”) reactions that may increase concentrations of inorganic compounds in the aquifer and recovered water. The redox reactions may result in higher dissolved concentrations of inorganic constituents in recovered water than in the injected water. Specifically, arsenic, iron, manganese, nitrogen, selenium, and sulfur have been identified as constituents of concern in ASR projects.

Several local municipalities in the North Coast Region have begun to study local conditions and pursue ASR projects that use treated, potable water. While site-specific characteristics and geochemical reactions are not yet known as to how disinfection byproducts will react in the subsurface, the presence of these compounds is reason for caution. Compliance with the proposed chemical constituents and groundwater toxicity objectives will require close consideration of the potential for disinfection byproducts to exceed water quality objectives and impact beneficial uses. The beneficial use of most concern is the domestic well owner who draws drinking water for use untreated. The injection of treated drinking water into an aquifer which results in the detection of disinfection byproducts in excess of public health goals at domestic drinking water wells could be determined to be a violation of water quality standards, including a violation of the antidegradation policy. But numerous potential techniques exist to ensure continued maintenance of high quality water and protection of human health. For example, treatment of injected water at the wellhead could remove or reduce constituents of concern. Use of alternative disinfection processes (alternatives to chlorination) could reduce the potential that chemicals of concern will impact groundwater quality. ASR projects could be sited only in those locations a reasonable distance from any potential domestic drinking water wells. An ASR project design could include enough water quality monitoring to quickly detect whether or not constituents of concern are migrating in a manner which risks the quality of domestic drinking water wells. The rate, volume and depth of injection could be managed based on the results of groundwater monitoring. With the application of such compliance measures and based on a project-specific evaluation, the proposed WQO Update Amendment does not have a significant adverse effect on local plans, policies or zoning ordinances.

Reliance on alternative water sources, water conservation efforts, preservation of areas of known thermal refugia, preservation of shade, and measures to ensure stream flows could have a conflict with local plans or ordinances that call for an increase through various water supply and/or development projects. Municipal, domestic, agricultural and industrial water supply could be impacted by certain restrictions on the extraction of water from riparian areas or areas of known thermal refugia. Construction or expansion of off-stream water storage facilities could conflict with local plans or ordinances. The development of project-specific remedial action plans that take site characteristics including, geology, hydrology, environmental setting, and onsite and nearby structures into account can mitigate such adverse impacts. Additionally, ensuring proper design, siting, and operational timing to reduce alterations of natural hydrology and adverse effects on stream and groundwater quality and quality from structural compliance measures can be done in advance with proper planning and site characterization. Therefore, the potential impacts from such compliance measures can be adequately mitigated to levels of less than significant.

LAND USE AND PLANNING: c) Less than Significant with Mitigation Incorporated
Discussion: Depending on the structural compliance measures selected, direct or indirect impacts to existing fish or wildlife habitat may occur; however, any such impact would be temporary. Compliance measures that may not have an impact when implemented in one area could potentially have an impact if they are implemented in a sensitive area. For instance the construction of a compliance measure such as a groundwater remediation facility could be located in an identified habitat conservation area. Therefore, when installing structural compliance that may include substantial earth movement, responsible parties will be required under their applicable permit (or as necessary to comply with applicable prohibitions), to consult with various federal, state and local agencies, including but not limited to the county the project is located in, CDFG and the USFWS. Typically

Regional Water Board staff work with other agencies and project proponents on the development of Habitat Conservation Plan (HCP) or Natural Community Conservation Plan (NCCP) to ensure compliance with all regulations.

If appropriate to avoid conflicts with any HCP or NCCP, the timing and/or location of the BMPs may be adjusted to reduce any potential conflict with any such plans. If, however, such adjustments could not be made, the compliance measures would have to be changed to avoid any adverse impacts to rare, threatened or endangered species, or the discharge would not be permitted to occur. Because of these mitigation requirements, conflict with the provisions of an adopted HCP or NCCP is not likely to occur. Therefore the appropriate finding is less than significant with mitigation incorporated. For further details see the previous section discussing biological resources. Additional mitigation measures are detailed in Section 5.4.3 and Table 5-1.

XI. MINERAL RESOURCES -- Would the project:				
	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?			X	
b) Result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?			X	

MINERAL RESOURCES: a) and b) Less than Significant
Discussion: None of the compliance measures identified contemplate the use of non-structural or structural BMPs that would result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state or the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan. Therefore, the appropriate finding is no impact.

XII. NOISE -- Would the project result in:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?		X		
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?		X		
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?		X		
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?		X		
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?		X		
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?		X		

NOISE: a), b), c) d), e) and f) Less than Significant with Mitigation Incorporated
Discussion: Increased noise levels would likely be associated with heavy equipment operation associated with construction of structural compliance measures. Temporary increases in noise from remediation or treatment system maintenance or upgrades could occur. In addition, noise could be increased temporarily from trucks and heavy equipment during excavations. Additionally, an increase in noise from drill rigs installing monitoring wells, injection wells, or extraction wells or the use of pumps, mixers, and compressors to sample, remediate and treat water could also occur. The use of thermal treatment units/incineration can produce noise above ambient levels. Construction, modification or removal of facilities for the purpose of groundwater or surface water extraction, energy supply and/or recreation could result in short-term and long-term impacts from noise. For the most part, the implementation of structural compliance measures may result in localized increased noise levels that can be minimized or mitigated through project-specific noise control plans.

Noise control plans would need to account for decibels generated from project activities, peak noise working hours, evening working hours, equipment inspections, muffler inspections, nearby receptors, a compliant resolution process, and an operations contingency plan. For example, noise levels from activities such as construction and/or maintenance would not exceed the existing levels and the loudest activities from other construction actions can be planned during peak daily noise. Additional measures to mitigate noise include advanced notifications to neighboring properties, sound control structures and equipment use buffers. Based on the availability of mitigation measures to abate noise impacts, this effect is considered less than significant with mitigation incorporated.

Upgrades to wastewater treatment facilities could include permanent structural measures that would result in a substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project. Additionally, many groundwater cleanup sites have needed remedial treatment actions for several years and even in excess of a decade which could seem like more than just temporary impacts. However, through the availability of structural and non-structural mitigation measures to abate noise impacts, this effect is considered less than significant with mitigation incorporated. Mitigation measures to address potential noise impacts are further detailed in Section 5.4.3 and Table 5-1.

XIII. POPULATION AND HOUSING -- Would the project:				
	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?				X
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?				X
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?				X

POPULATION AND HOUSING: a), b) and c) No Impact
Discussion: None of the compliance measures identified would induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure). None of the compliance measures identified would displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere.

The proposed WQO Update Amendment has no effect on parameters that are typically evaluated in addressing potential growth inducement, such as generation of employment opportunities, provision of housing supply, generation of the sale of goods and services, removal of growth obstacles, expansion of infrastructure, or extension of utilities. The proposed Basin Plan amendment would not result in any substantial growth-inducing impacts. Therefore, there is no impact.

XIV. PUBLIC SERVICES				
	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:				
a) Fire protection?		X		
b) Police protection?			X	
c) Schools?			X	
d) Parks?			X	
e) Other public facilities?			X	

PUBLIC SERVICES: a) Less than Significant with Mitigation Incorporated
Discussion: Logically, the increase in riparian vegetation increases the fuel loads for wildfires. While fuel loads do not cause fires, the increasing mass available can increase severity of a fire and could impact the demand on fire protection services. Allowing for the removal or thinning of upland vegetation that has high evapotranspiration rates and increases fire risks could be a mitigation measure that results in multiple benefits to the environment. For more discussion see the section on aesthetics. The appropriate finding is less than significant with mitigation incorporated.

PUBLIC SERVICES: b) c), d) and e) Less than Significant
Discussion: The proposed WQO Update Amendment does not add new residents or change land uses, and therefore would not generate a need for new or additional fire protection, police protection, schools, parks or related services. Minor alterations to government facilities may be required if soil and/or groundwater remediation or wastewater treatment is necessary; however, this would be an existing requirement and there is only a very slight

potential for facility alterations based on the proposed revision to the water quality objectives. Therefore, the potential level of impact is less than significant.

With the widespread increase in marijuana cultivation throughout the region, both local and state law enforcement and resource agencies have seen an increase in the number of cases that lead to enforcement actions. Marijuana cultivation in the region has caused discharges of sediment and pesticides as well as an increased water demand. While many of these operations are legal under California law they are still illegal under federal law. According to Regional Water Board staff, many of these small and state legal operations are seeking input and making attempts to reduce their impacts to environment through routine BMPs that address erosion and sediment control, as well as water efficiency strategies. Still, many more large scale operations go fully beyond the scope law with little caution towards criminal and environmental legality. With observations spanning over the past few decades and special emphasis on the last few years, the demand on law enforcement including the Regional Water Board has already taken place. Moreover, while water quality objectives apply to marijuana growers with respect shade, sediment, and flow, these components do not necessarily implicate police resources. Therefore, a significant increase in the demand for public services has already occurred and the impact from this proposed Basin Plan amendment on police services is less than significant.

XV. RECREATION-- Would the project:				
	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?				X
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?			X	

RECREATION: a) No Impacts
Discussion: None of the compliance measures identified would increase the use of existing neighborhood and regional parks or other recreational facilities. No impact would occur.

RECREATION: b) Less than Significant
Discussion: It is possible that soil and/or groundwater contamination could occur next to or within a park or recreational facility, which would necessitate the installation of remedial actions or additional wastewater treatment. There could then be minor impacts to the park or recreational facility to conduct cleanup activities or upgrade wastewater

treatment capabilities. However, none of the compliance measures would be necessary to be implemented in such ways that substantially physically deteriorate a recreational facility or require the construction of new recreational facilities. Therefore, the potential impact is less than significant.

XVI. TRANSPORTATION/TRAFFIC -- Would the project:				
	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Conflict with an applicable plan, ordinance or policy establishing measures of effectiveness for the performance of the circulation system, taking into account all modes of transportation including mass transit and non-motorized travel and relevant components of the circulation system, including, but not limited to intersections, streets, highways and freeways, pedestrian and bicycle paths, and mass transit?		X		
b) Conflict with an applicable congestion management program, including, but not limited to level of service standards and travel demand measures, or other standards established by the county congestion management agency for designated roads or highways?		X		
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?		X		
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?		X		
e) Result in inadequate emergency access?		X		
f) Conflict with adopted policies, plans, or programs regarding public transit, bicycle, or pedestrian facilities, or otherwise decrease the performance or safety of such facilities?			X	

TRANSPORTATION/TRAFFIC: a), b), c), d) and e) Less than Significant with Mitigation Incorporated

Discussion: Groundwater investigations and construction activities from remedial system upgrades or upgrades to wastewater treatment plants have the potential to increase traffic volumes, reduce speeds on public roads, and result in temporary lane closures, which could also temporarily affect current levels of service and emergency access. The amount of traffic would vary on the project-specific basis, depending on the upgrade or investigation needs. As such, it would require analysis on a case-by-case basis. Most potential traffic related impacts are likely to be temporary and associated with construction of additional facilities. Any impacts on traffic associated with increased operation and maintenance of treatment facilities is likely negligible as compared to the existing traffic baseline. Lane closures have the greatest potential to upset traffic patterns and create significant impacts and would require obtaining public right-of-way encroachment permits and the development of a traffic control plan. Traffic control plans include signage locations, though traffic routes, designated truck routs, construction sites access, designated work and staging areas, parking areas, pedestrian and bicycle safety access, detours and lane closures, emergency access routes and detours, and flaggers. Additional mitigation may include nighttime work to avoid heavily congested or commuter areas. Based on the potential traffic impacts and the available mitigation measures, the appropriate finding is less than significant with mitigation. Additional mitigation measures are detailed in Section 5.4.3 and Table 5-1.

Increased tree retention may conflict with the site distance requirements of transportation agencies (public roads) areas designated as clear recovery zones. Different levels of road systems (e.g. freeways, highways, interstates, city streets and county roads) have various levels of design requirements in consideration of site distance to help ensure public safety. In addition, clear recovery zones (areas adjacent to road shoulders) are created and maintained in certain locations outside the highway shoulder to provide an opportunity for vehicles that leave the roadway to come to a safe stop or to return to the roadway. A recoverable slope is a slope on which a motorist may, to a greater or lesser extent, retain or regain control of a vehicle by slowing or stopping. Slopes flatter than 1:4(vertical/horizontal) are generally considered recoverable (U.S. Federal Highway Administration).

Thousands of miles of roads either parallel or intersect streams, riparian areas and/or floodplains. Therefore, it is possible that retaining riparian vegetation to provide site potential shade or the installation of sediment control compliance measures could infringe upon site distance or clear recovery zone requirements. However, with proper planning and coordination with local, county and state transportation agencies most conflicts could be resolved. For instance, during the road planning, design and environmental impact assessment stages, these types of constraints or conflicts are analyzed by transportation engineers and biologists. Through the existing project planning, CEQA process, interagency coordination and existing regulation (NPDES storm water permits and 401 Certifications) potential conflicts are resolved by avoidance, minimization, or offsite compensatory mitigation. For example, many structural BMPs designed to reduce sediment and polluted storm water runoff has often been determined to be possible to construct, but infeasible due to safety constraints. Alternately, adequately vegetated slopes flatter than 1:4(vertical/horizontal) are also potential locations for structural BMPs such as biofiltration of polluted storm water and are known to reduce erosion and sediment transport. Through proper coordination, planning and design clear recovery zones can meet public safety, storm water treatment, and erosion and sediment control goals. Therefore, it is staff's determination that the potential impacts are less than significant with mitigation incorporated.

TRANSPORTATION/TRAFFIC: f) Less than Significant
Discussion: The proposed project does not involve air traffic or require the installation of hazardous design features on roads. The proposed project will not conflict with policies, plans, or programs regarding public transit, bicycle, or pedestrian facilities, or otherwise decrease the performance or safety of such facilities. Because the proposed project does not involve these elements, the appropriate finding is no impact.

XVII. UTILITIES AND SERVICE SYSTEMS -- Would the project:				
	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?			X	
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?		X		
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?		X		
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?		X		
e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?				X
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?			X	
g) Comply with federal, state, and local				

statutes and regulations related to solid waste?				X

UTILITIES AND SERVICE SYSTEMS: a) and f) Less than Significant
Discussion: The proposed WQO Update Amendment itself will not exceed applicable wastewater treatment requirements. WDRs and NPDES permits are already implementing more stringent objectives than those listed in the Basin Plan for chemical constituents and groundwater toxicity, which are based on current Title 22 regulations, Basin Plan Table 3-2 footnote 2, the SIP, the antidegradation policy and SWRCB Resolution 92-49. In theory the numeric values of the water quality objectives for chemical constituents and groundwater toxicity will be changed. However, in current practice the numeric values used in permits, orders and other regulatory actions are derived through the applications of various plans policies as mentioned above. For example the SIP and antidegradation policy is and will be the guiding policy for the development of effluent limitations in NPDES permits. Additionally, SWRCB Resolution 92-49 and the antidegradation policy will be the predominant guiding policies for groundwater cleanup and protection efforts.

In the absence of a toxicity objective for groundwater, Regional Water Board staff has relied on alternative justifications and authority for establishing cleanup levels and permit limits to address toxic constituents of concern, such as the federal and state antidegradation policies and State Water Board Order No. 92-49. Adopting a specific groundwater toxicity objective will provide a sounder and more transparent regulatory standard to address the cleanup of toxic substances in groundwater. However, it will not significantly alter the limits in permits, orders, and other regulatory actions as compared to that which is currently produced by cleanup staff using alternative justifications. This argument also holds true for the generation of any waste byproduct in need of disposal.

The revision of the chemical constituents objective for surface water and groundwater also results in bringing the Basin Plan up to date with the Regional Water Board's longstanding interpretation of the language. For example, the outdated numeric criteria in Table 3-2 are typically not used in permits, orders, or other regulatory actions. Instead, footnote 2 to Table 3-2 is interpreted to mean that any more stringent criteria appropriate for the protection of sensitive beneficial uses can be used when establishing a permit, order or other regulatory action. Similarly, the combination of footnote 2 and application of the groundwater toxicity objective for surface water, often lead staff to the development of numeric criteria that protect not only the MUN beneficial use, but other beneficial uses such as aquatic life and human consumption of aquatic organisms, as is otherwise required under Porter-Cologne.

In addition to the narrative groundwater toxicity objective, and the revision of the chemical constituents objective for surface water and groundwater, the WQO Update Amendment removes other obsolete information and revises existing language so as to make the Basin Plan more consistent with current Regional Water Board practice. As above, these changes will have no impact on how existing regulatory programs are implemented. Therefore, the impact is less than significant.

UTILITIES AND SERVICE SYSTEMS: b), c) and d) Less than Significant with Mitigation Incorporated

Discussion: There is the potential that the proposed Basin Plan amendment could result in the need to upgrade a wastewater treatment plant as happens from time to time when federal or state water quality standards change or treatment capabilities improve. But, there may be many options to consider prior to deciding on the need for structural upgrades. The specific constituents of concern, the discharge locations and flow restrictions, influent concentrations, effectiveness of source controls, as well as many other factors must be taken into account when determining the proper method of compliance. If expansions occur for any variety of reasons, including the need for additional treatment capabilities to meet water quality standards, then construction type impacts are likely to occur as described above, including mitigations to reduce the impacts to less than significant. Construction, expansion, or installation of many of the compliance measures described above have the potential to adversely affect air quality, sensitive biological species, fill wetlands or streams, produce hazardous substances, result in soil erosion, create noise and affect traffic depending on the treatment plant's upgrade needs. But generally speaking, these issues can be mitigated as discussed in the previous sections. Therefore, the appropriate finding is less than significant with mitigation.

Several compliance measures including, but not limited to, sediment control basins, LID features, irrigation systems and tailwater management systems designed to reduce sediment transport to streams have the potential to cause an impact on utilities. However, mitigation measures can reduce any impacts to a less than significant level. Additional mitigation measures are detailed in Section 5.4.3 and Table 5-1.

Should compliance with the proposed Basin Plan amendment require a reduction in surface water withdrawls and a greater reliance on groundwater or alternate water sources, then there could be impacts on the existing water and energy delivery systems. The degree of impact would depend on which compliance measures are implemented, the local hydrology, and other factors. In addition, surface water supplies may be insufficient to meet all future demands even in the absence of any impacts derived from implementation of the proposed Basin Plan amendment. Surface water resources are already limited in some areas and future water supplies will be limited by the natural supply availability rather than by restrictions on water diversion and storage. Some streams in the region area are already fully appropriated for some or all of the year. The selection of the appropriate compliance measures by responsible parties will need to take into consideration their existing water resources. Basing selection of compliance measures on existing water resources will prevent the need to seek new water rights.

Another alternative water supply practice for water purveyors currently being considered in the North Coast Region is groundwater banking, also known as ASR. With potential restrictions on municipal water supplies there is the potential for ASR projects to become more common place throughout the region. There are potential adverse environmental impacts associated with these types of projects. But, there are potential environmental benefits worthy of evaluation on a case-by-case basis.

UTILITIES AND SERVICE SYSTEMS: e) and g) No Impact
Discussion: None of the potential compliance measures have any potential to increase the need for storm water facilities, change the demand on water supplies, require additional capacity for wastewater treatment, or conflict with any solid waste disposal regulation. No impact.

XVII. MANDATORY FINDINGS OF SIGNIFICANCE				
	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?		X		
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	X			
c) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?		X		

Many of the projects that might be undertaken by affected persons as a result of the Policy would be subject to a project-level CEQA review conducted by the Regional Water Board or by another lead agency, which would entail project-specific identification and mitigation of any significant environmental effects. In addition, other regulatory mechanisms can be expected to provide opportunities for minimizing and avoiding significant environmental effects. Regulatory requirements and mitigation measures are described throughout this chapter of the Staff Report and summarized in this document. These regulatory requirements and mitigation measures are likely to reduce many, but not all, of the potential impacts of the Basin Plan Amendment to less than significant levels. In some cases it may not be possible to mitigate the impacts of the Policy to a less-than-significant level

MANDATORY FINDINGS OF SIGNIFICANCE a) Less than Significant with Mitigation
Discussion: The proposed WQO Update Amendment does have the potential for significant adverse effect on the environment. While impacts requiring mitigation measures could potentially occur, the compliance measures are for the purpose of reducing pollution concentrations discharged to waters and remediating contaminated waters to levels that protect all beneficial uses, including agricultural water use, municipal and domestic water use, wildlife habitat and rare, threatened and endangered species. However, as noted in the analysis above the compliance measures identified do have the potential to degrade fish and wildlife habitat. Additionally, several of the compliance measures could restriction the range of rare and endangered plants.

All of the compliance measures identified in this environmental analysis are designed to improve water quality. However, compliance measures that require substantial earth movement will likely require consultation with federal, state and local agencies, including but not limited to the county the project is located in, CDFW and the USFWS. Specific mitigation measures will be required by these agencies so as to avoid impacts to rare, threatened or endangered species.

Potential restrictions in range or impacts to fish or wildlife habitat from compliance measures identified in the Staff Report include:

- The removal of surface water impoundments could result in a short term violation of water quality standards as sediments and organic rich waters flow downstream.
- The removal of on-stream and off-stream storage facilities, dams, and construction of minimum bypass flow and fish passage structures could result in changes to hydrology in streams as well as short term violation of water quality standards.
- Switching from on-stream storage facilities to springs, seeps or groundwater as potential water sources could reduce the input of cold water and could results in impacts to areas of thermal refugia.
- Risk of introducing invasive species thorough pasture, hay, rangeland planting and management and stream or riparian restoration.

- Risk of conflict between site potential shade and requirements of sensitive flora or fauna.
- Phytoremediation and constructed wetlands could result in bioaccumulation of toxic compounds if primary producing organisms became prey for threatened or endangered species.
- Phytoremediation and constructed wetlands could result in the transfer of contaminants across media from soil and water to air.
- Operations of aeration systems for DO have the potential to supersaturate conditions, exceed water quality standards and lead to accelerated mortality rates of salmoninds.
- Short term construction, stream dewatering or diversions, turbidity discharges from construction actives or in-stream dam removal, stream and/or riparian restoration.
- Several species of fauna (e.g., snakes, fish, salamanders, and birds) have been entrapped or tangled in erosion control products such as the plastic casing covering straw waddles, or from the monofilament fibers from silt fences that are either in place on active
- Loss of wetlands habitat from repair of leaky conveyance systems or alteration of irrigation practices.
- Loss of critical habitat from sediment discharges.
- Loss of warm water habit for non-native species.
- Switching from on-stream storage facilities to springs, seeps or groundwater as potential water sources could reduce the input of groundwater to surface waters and could results in impacts to areas of thermal refugia
- Reduction in surface flows through groundwater extraction or increased reliance on riparian rights could degrade riparian and special status species habitat
- Construction or reservoir removal has the potential to significantly impact water quality from the release of increased loads of fine grained sediment degrading aquatic ecosystem habitat.

The adoption of the proposed WQO Update Amendment should result in improved water quality in the North Coast Region and will have a significant beneficial effect on the environment over the long-term; however, it should be noted that compliance measures do have the potential to adversely impact the environment. In most cases, the impacts of installing structural compliance measures will be temporary, and many likely can be avoided by adjusting the timing and/or location so as to take into account any candidate, sensitive, or special status species or their habitats. Therefore, with correctly implemented mitigation measures these impacts are considered less than significant. For a detailed list of potential mitigation measures see Section 5.4.3 and Table 5-1.

MANDATORY FINDINGS OF SIGNIFICANCE b) Potentially Significant and Unavoidable Discussion: Cumulative impacts, defined in section 15355 of the CEQA Guidelines, refer to two or more individual effects, that when considered together, are considerable or that increase other environmental impacts. Cumulative impact assessment must consider not only the impacts of the proposed Basin Plan amendment, but also the impacts from other Basin Plan amendments, municipal and private projects which have occurred in the past, are presently occurring, and may occur in the future in the watershed during the period of implementation.

Impacts associated with implementation of most of the structural measures will be short-term, temporary and spatially distributed across a watershed or region, and will not have significant adverse effects on the environment. Compliance measures that involve substantial earth movement could have potentially significant cumulative impacts. However, many of these activities will be regulated under existing State and Regional permits. Regional Water Board staff's engagement in these regulatory programs will provide an opportunity to limit the potential for cumulative impacts by ensuring that multiple projects proposing implementation of BMPs with the potential to cause short-term impacts are phased appropriately to limit potential cumulative impacts.

Based on a review of the available information, and as a result of implementing the range of compliance measures from the preservation of shade to sediment controls and the modification of water supply to the potential expansion of wastewater treatment and groundwater remediation facilities, it has been determined that significant and unavoidable impacts to the environment have the potential to occur. In most cases these are impacts that are potentially widespread or common throughout the region, and could lead to cumulative watershed and/or region-wide impacts. Cumulative impacts are especially significant in areas that are already listed as impaired or otherwise degraded since the system or species has already lost resilience to external stressors. Due to the fact that many streams in the region are impaired and several rare, threatened and endangered are present throughout the region any adverse impact that has the potential to occur in multiple instances could be considered significant and unavoidable. Many of the potential impacts discussed below and throughout this analysis can be reduced through proper implementation of mitigation measures; however, cumulatively these impacts do have the potential for significant adverse effects on the environment.

- The removal of surface water impoundments could result in a short term violation of water quality standards as sediments and organic rich waters flow downstream.
- The removal of on-stream and off-stream storage facilities, dams, and construction of minimum bypass flow and fish passage structures could result in changes to hydrology in streams as well as short term violation of water quality standards.
- Switching from on-stream storage facilities to springs, seeps or groundwater as potential water sources could reduce the input of cold water and could results in impacts to areas of thermal refugia.
- Risk of introducing invasive species thorough pasture, hay, rangeland planting and management and stream or riparian restoration.
- Risk of conflict between site potential shade and requirements of sensitive flora or fauna.

- Several species of fauna (e.g., snakes, fish, salamanders, and birds) have been entrapped or tangled in erosion control products such as the plastic casing covering straw waddles, or from the monofilament fibers from silt fences that are either in place on active
- Loss of wetlands habitat from repair of leaky conveyance systems or alteration of irrigation practices.
- Loss of critical habitat from sediment discharges.
- Pump and treat systems could result in a lower of the groundwater table or an alteration of hydrology by impeding the natural groundwater gradient.
- Pump and treat systems could alter a sites hydrology and adversely affect nearby streams, riparian areas or wetlands.
- Pump and treat systems could result in the alteration of nearby stream hydrology adding to the total flow in the stream.
- Land application of wastewater could result in groundwater quality impacts through the accumulation of organics, salts, or precipitation of naturally occurring metals in soils.
- Reduction in stream flows due to the increase in evapotranspiration from increased riparian tree retention.
- Temporary sediment discharges that exceed water quality objectives from construction and/or restoration activities.
- Excessive use of rip-rap or stream stabilization structures intended to beneficially affect flow could alter conditions downstream.
- Increased risk of soil or groundwater contamination with concentrated minerals, salts, or persistent pesticides.

Most of these potential impacts are expected to be short-term. Individual project-specific CEQA review will be necessary in those cases as appropriate. Many can and will be mitigated to less than significant levels with the implementation of specific mitigation measures. However, because of the programmatic nature of this CEQA analyses, it is not possible to say with certainty that all impacts will be mitigated to less than significant levels. Identified mitigation will become enforceable in permits and other orders by the Regional Water Board, but we cannot be certain that other agencies will adopt the recommended mitigation for activities under the jurisdiction of other agencies. As a result, even impacts identified as less than significant with mitigation incorporated must also be considered unavoidable at this time.

Notwithstanding the potential negative affects discussed above and throughout this Staff Report it is likely that long-term beneficial effects will be realized on aesthetic resources, biological resources, geology and soils, GHG emissions, hydrology and water quality, and recreation.

MANDATORY FINDINGS OF SIGNIFICANCE c) Less than Significant with Mitigation
Discussion: The purpose of updating and revising water quality objectives, specifically chemical constituents and groundwater toxicity, are to protect human health as well as aquatic ecosystem health. Additionally, water quality objectives are in place to protect human health and the environment. Some of the compliance measures do have the potential to adversely affect humans such as noise from construction, or hazardous construction or remediation project conditions.

Unsightly views of additional wastewater treatment ponds, waste management/treatment units, reservoir or stream aeration structures could degrade the scenic view of a site. Thermal destruction incinerators or phytoremediation actions could produce off-gas requires treatment by an air pollution-control system to remove particulates and neutralize and remove acid gases (e.g. HCl, NO_x, and SO_x). Additionally, exposure to hazardous liquids, solids or gases from construction, demolition or remedial actions presents a potential danger to humans. However, these measures are mitigated through careful project-specific planning, assessment, and preparation or such mitigation measures as noise control plans, best management practices, health and safety plans and trainings. Additional, mitigation measures are listed in Section 5.4.3 and Table 5-1 of this Staff Report.

As explained previously, the proposed WQO Update Amendment is designed to improve long-term water quality by providing a regulatory program designed to protect and restore water quality and the beneficial uses of water in the North Coast Region. An important objective of the proposed WQO Update Amendment is the restoration of a healthy and viable salmonid fishery and the preservation of high quality waters. Finally, the adoption of a groundwater toxicity objective is based on the need to protect the beneficial use of individual domestic water supplies from potential continents that can cause toxicity in humans.

5.6 Alternative Means of Compliance

The CEQA requires an analysis of reasonably foreseeable alternative means of compliance with the rule or regulation, which would avoid or eliminate the identified impacts[13]. The responsible parties can use the structural and non-structural compliance measures described in Section 5.4.1 and 5.4.2 and Table 5-1, or other structural and non-structural compliance measures, to control and prevent pollution, and meet the requirements of the proposed Basin Plan amendment. The alternative means of compliance consist of the different combinations of structural and non-structural compliance measures that the responsible parties might use to meet their permit limits and achieve compliance with the water quality standards. Because there are innumerable ways to combine compliance

[13] Cal. Code Regs., tit. 14, § 15187 sudb. (c)(3).

measures, all of the possible alternative means of compliance cannot be discussed here. However, because most of the adverse environmental effects are associated with the construction of structural compliance measures related to earth movement or construction of infrastructure (e.g., wastewater and groundwater treatment facilities, fencing, off-channel water facilities, aquatic ecosystem restoration restoration) to avoid or eliminate impacts, project proponents should always maximize the use of non-structural measures to the extent feasible, and design structural compliance measures to take into consideration site-specific conditions to minimize environmental effects.

TABLE 5-1 WATER QUALITY OBJECTIVE UPDATE AMENDMENT CEQA REQUIREMENTS POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES				
Compliance Measures	Environmental Factor	Potential Environmental Impact	Mitigation Measure	Level of Significance
Construction, installation, and operation of soil/groundwater remediation, wastewater treatment facilities, and reservoir or stream aeration structures Preserve, maintain, and restore site specific potential shade Measures to address tailwater and surface water impoundments Preservation of existing cold water resources Measures to Restore and Maintain Stream Flows	Aesthetics	Degraded visual character of a site. Unsightly views of additional wastewater treatment ponds, waste management/treatment units, reservoir or stream aeration structures Decreased views or unsightly presence in a scenic vista due to the installation of additional mitigation or remediation equipment or associated material storage necessary to cleanup spills, unauthorized releases, treat wastewater, physically address DO. Potential glare from ponds or unsightly water facilities	AesMM-1: Building storage facility structures or fences to contain equipment or materials. AesMM-2: Proper siting, constructing berms or excess freeboard around the perimeter of a ponds or waste management unit. AesMM-3: Planting vegetation such as native trees, grasses, and forbs.	Less than significant with mitigation
Preserve, maintain, and restore site specific potential effective shade Erosion and sediment control		Decrease scenic views of waterbodies through the retention or planting of vegetation.	Not applicable	Less than significant
Preserve, maintain, and restore site specific potential effective shade	Agriculture	Potential conflict with or conversion of prime agricultural land or land subject to the Williamson Act from implementing grazing restrictions, riparian buggers or riparian restoration. Municipal, domestic, agricultural and industrial water supply could be	AGRMM-1: Coordination between project proponents, Regional Water Board staff and other local, state and federal agencies to achieve site specific potential shade, nutrient load reductions, areas of thermal refugua, and attempt to ensure the preservation of agricultural lands.	Potentially significant and unavoidable with mitigation

TABLE 5-1
WATER QUALITY OBJECTIVE UPDATE AMENDMENT
CEQA REQUIREMENTS
POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Compliance Measures	Environmental Factor	Potential Environmental Impact	Mitigation Measure	Level of Significance
Riparian buffers and grazing restrictions Preservation of existing cold water resources Measures to Restore and Maintain Stream Flows Erosion and sediment controls Measures to address tailwater and surface water impoundments		impacted by certain restrictions on the extraction of water from riparian areas or areas of known thermal refugia. Switching from surface water diversions to groundwater pumping could lower water table, reduce soil moisture, contribute to land subsidence and reduce aquifer storage capability. Regulation on water use could lead to the conversion of agricultural lands.		
Construction, installation, and operation of soil/groundwater remediation, wastewater treatment facilities, and reservoir or stream aeration structures Aquatic Ecosystem Restoration Preservation of existing cold water resources Measures to Restore and Maintain Stream Flows	Air Quality	Construction-related emissions could include exhaust from construction equipment and fugitive dust from land clearing, earthmoving, movement of vehicles, and wind erosion of exposed soil during reservoir construction or removal, stream and/or riparian restoration. Increased emissions or gases from the expansion and/or extended operation and maintenance of remedial action facilities. Potential odors from stagnant water in sediment basins or ponds. Potential increase in emissions from transportation of soil and groundwater for offsite disposal. Thermal destruction incinerators or phytoremediation actions could produce off-gas requires treatment by an air pollution-control system to remove particulates and neutralize and remove acid gases (HCl, NO_x, and SO_x).	AQMM-1: Air Quality Control Plans ▪ Monitoring and Reporting ▪ Dust control ▪ Avoid days or poor air quality ▪ Monitor levels and cease work prior to exceeding standards ▪ Retrofit equipment ▪ Use low emissions vehicles when possible ▪ Schedule work to reduce the use of high emission vehicles. ▪ Contingency Plans for AQ Violations AQMM-2: Particulate matter and gas removal systems • Baghouses, scrubbers, and wet electrostatic precipitators; packed-bed scrubbers and spray driers.	Less than significant with mitigation

TABLE 5-1 WATER QUALITY OBJECTIVE UPDATE AMENDMENT CEQA REQUIREMENTS POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES				
Compliance Measures	Environmental Factor	Potential Environmental Impact	Mitigation Measure	Level of Significance
Erosion and sediment control Soil and groundwater cleanup/thermal destruction				
Soil and groundwater cleanup Preservation of existing cold water resources Measures to Restore and Maintain Stream Flows		Potential increase in emissions from transportation of soil and groundwater for offsite disposal. Alternative water supplies or increased pumping could result in long term increase in greenhouse gases. Potential byproducts include airborne hydrogen sulfide, vinyl chloride, methane, ethane, and ethene.	NA	Less than significant
Construction, installation, and operation of soil/groundwater remediation, wastewater treatment facilities, and reservoir or stream aeration structures Grazing management plan Preserve, maintain, and restore site specific potential effective shade Rangeland planting	Biological Resources	Risk of introducing invasive species thorough pasture, hay, rangeland planting and management and stream or riparian restoration. Risk of conflict between site potential shade and requirements of sensitive flora or fauna. Phytoremediation and constructed wetlands could result in the transfer of contaminants across media from soil and water to air. Phytoremediation and constructed wetlands could result in bioaccumulation of toxic compounds if primary producing organisms became prey for threatened or endangered species. Operations of aeration systems for DO have the potential to supersaturate conditions, exceed water quality standards and lead to accelerated mortality rates of salmoninds. Short term construction, stream dewatering or diversions, turbidity discharges from construction actives or in-stream dam removal, stream and/or riparian restoration. Several species of fauna (e.g., snakes, fish, salamanders, and birds) have been entrapped or tangled in erosion control products such as the plastic casing	BRMM-1: Consult the applicable state and federal resource protection agencies BRMM-2: Delineate and avoid any project specific environmental sensitive areas. BRMM-3: Species specific work windows to avoid contact or disturbances. BRMM-4: Compensatory mitigation to create, replace, or restore filled or modified waters of the U.S. (streams and wetlands). BRMM-5: Remedial action plans proposing phytoremediation would need to evaluate the potential for bioaccumulation of toxic compounds and select plans species that will not become primary producers in the food chain. BRMM-6: Use certified weed-free grass and seed mix to prevent the introduction of invasive species. BRMM-*7:* Select appropriate or alternate structural BMPs such as bio-degradable, synthetic free or earthen material BMPs. Implement non-structural BMPs such as scheduling, proper design and the removal of temporary BMPs for erosion and sediment controls after stabilization and or project completion.	Less than significant with mitigation

TABLE 5-1 WATER QUALITY OBJECTIVE UPDATE AMENDMENT CEQA REQUIREMENTS POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES				
Compliance Measures	Environmental Factor	Potential Environmental Impact	Mitigation Measure	Level of Significance
Reservoir or stream aeration structures Phytoremediation Constructed Wetlands Erosion and sediment control Measures to Restore and Maintain Stream Flows		covering straw waddles, or from the monofilament fibers from silt fences that are either in place on active Loss of wetlands habitat from repair of leaky conveyance systems or alteration of irrigation practices. Loss of critical habitat from sediment discharges. Loss of warm water habit for non-native species. Reduction in surface flows through groundwater extraction or increased reliance on riparian rights could degrade riparian and special status species habitat	BRMM-8: Developing species relocation plans or interpreting natural site vegetative conditions to include sensitive flora. BRMM-9: Water drafting protocols • Consult CA Fish and Wildlife • Consult SWRCB – Water Rights • Use water diversion fish screens • Velocity dissipaters • Habitat surveys • Stream buffers AQMM-1: Air Quality Control Plans • Monitoring and Reporting • Contingency Plans for AQ Violations H/WQMM-1: Develop storm water pollution prevent plans. H/WQMM-2: Water Quality Monitoring H/WQMM-3: Develop project specific remedial action plans that take site characteristics including, geology, hydrology, environmental setting, and on-site and nearby structures into account. H/WQMM-4: Implement flow rate modeling, monitoring, prohibitions and restrictions within specific Regional Water Board permits and orders. H/WQMM-5: Plant native vegetation that has evolved with the natural environment. Allow for the removal or thinning of upland vegetation that has high evapotranspiration rates and increases fire risks.	
Construction and installation of soil/groundwater remediation and wastewater treatment facilities Well installation	Cultural Resources	Construction disturbance from earth moving.	CRMM-1: Consult with Tribes, historical societies, federal, state and local agencies regarding location of cultural resources prior to use of heavy equipment in areas with known or suspected cultural resources. Projects subject to the jurisdiction of the Water Boards will be required to comply with Public Resource Code section 21159. This is expected to ensure the implementation of necessary project specific actions to avoid, minimize and mitigate any impacts to historical, archaeological, and paleontological resources or site, or unique geologic features. All future actions must comply with the CEQA process and requirements for tribal consultation provided by	Less than significant with mitigation

TABLE 5-1 WATER QUALITY OBJECTIVE UPDATE AMENDMENT CEQA REQUIREMENTS POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES				
Compliance Measures	Environmental Factor	Potential Environmental Impact	Mitigation Measure	Level of Significance
Excavation Physical barriers Ponds and lagoon construction Aquatic Ecosystem Restoration Erosion and sediment control Measures to address tailwater and surface water impoundments Preservation of existing cold water resources Measures to Restore and Maintain Stream Flows			Senate Bill 18 (SB 18) (State 2004, Ch 905) and Government Code section 65252.	
Construction, installation, and operation of soil/groundwater remediation facilities Well installation Excavation Physical barriers Ponds and lagoons Aquatic ecosystem restoration	Geology and Soils	Implementation of compliance measures such as wells, ponds, trenches, excavations and other treatment facility expansions that involve construction may result in temporary ground disturbances that cause erosion. Soil excavation and trenching could result in erosion or soil collapse. Installation of remedial/treatment facilities on expansive soils. Potential soil erosion from disturbed areas associated with stream stabilization, stream bank revegetation, culvert replacement, stream crossing construction, large woody debris placement. Construction activities or poorly designed facilities could results in short term and long term erosion, and could results in soils compaction reducing soil moisture and biological functions.	H/WQMM-1: Develop storm water pollution prevent plans. GSMM-1: Include erosion control measures in facility pollution prevent plans, remedial action plans, or site health and safety plans. H/WQMM-3: Develop project specific remedial action plans that take site characteristics including, geology, hydrology, environmental setting, and on-site and nearby structures into account.	Less than significant with mitigation

TABLE 5-1
WATER QUALITY OBJECTIVE UPDATE AMENDMENT
CEQA REQUIREMENTS
POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Compliance Measures	Environmental Factor	Potential Environmental Impact	Mitigation Measure	Level of Significance
Erosion and sediment control Preservation of existing cold water resources Measures to Restore and Maintain Stream Flows				
Construction, installation, and operation of soil/groundwater remediation, wastewater treatment facilities, and variable outlet structures Upgrade or expansion of waste water treatment facilities Reservoir or stream aeration structures Measures to restore and maintain stream flows	Hazards and Hazardous Materials	Accidental spill or release of materials which have been removed from soil and or groundwater though a remediation or treatment action or from the construction of such facilities. Natural attenuation if not monitored correctly could result allow the migration of hazardous substances. In-situ and ex-situ physical, chemical and thermal remediation or treatments, by design, have the potential to create byproducts or mobilize pollutants in air, soil, and water. Physical, chemical and biological treatment of wastewater has the potential to create byproducts or mobilize pollutants in air and water. Increased amounts of compressed oxygen or generators that require fuels to operated.	H/WQMM-1: Storm Water Pollution Prevent Plans H/WQMM-2: Water Quality Monitoring H/WQMM-3: Develop site specific remedial action plans that take site characteristics including, geology, hydrology, environmental setting, and on-site and nearby structures into account. AQMM-1:Air Quality Control Plans • Monitoring and Reporting • Contingency Plans for AQ Violations HHMMM-1: Project specific health and safety plans	Less than Significant with mitigation
Measures to address tailwater and surface water impoundments Preservation of existing cold water resources	Hydrology/ Water Quality	The increase in groundwater extraction could reduce surface water flows and result in increased pollutant concentration due to less dilution. The removal of surface water impoundments could result in a short term violation of water quality standards as sediments and organic rich waters flow downstream.		Potentially significant and unavoidable

TABLE 5-1 WATER QUALITY OBJECTIVE UPDATE AMENDMENT CEQA REQUIREMENTS POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES				
Compliance Measures	Environmental Factor	Potential Environmental Impact	Mitigation Measure	Level of Significance
Measures to Restore and Maintain Stream Flows		The removal of on-stream and off-stream storage facilities, dams, and construction of minimum bypass flow and fish passage structures could result in changes to hydrology in streams as well as short term violation of water quality standards. Switching from on-stream storage facilities to springs, seeps or groundwater as potential water sources could reduce the input of cold water and could results in impacts to areas of thermal refugia.		
Construction, installation, and operation of soil/groundwater remediation, wastewater treatment facilities, and variable outlet structures Upgrade or expansion of waste water treatment facilities Well installation Excavation Physical barriers Settling ponds Aeration ponds Preserve, maintain, and restore site specific potential shade Reservoir or stream aeration structures	Hydrology/ Water Quality	Spills, leaks or discharges from the construction of compliance measures could directly affect water quality and indirectly affect waters by polluting storm water runoff. Soil excavations, compost operations or land farming could result in erosion, sedimentation of nearby waters. During the reductive de-chlorination process, metals, such as arsenic, manganese and antimony, may be mobilized in the subsurface. PCE is reductively de-chlorinated to Trichloroethylene (TCE), cis- and trans-1,2-DCE and vinyl chloride (VC). Ozone injection can cause chromium III to turn to chromium VI. Fracturing hydraulically separate zone could lead to cross contamination of uncontaminated aquifers, water bearing zones, or nearby surface waters. Pump and treat systems could result in a lower of the groundwater table or an alteration of hydrology by impeding the natural groundwater gradient. Pump and treat systems could alter a sites hydrology and adversely affect nearby streams, riparian areas or wetlands. Pump and treat systems could result in the alteration of nearby stream hydrology adding to the total flow in the stream. Land application of wastewater could result in groundwater quality impacts through the accumulation of organics, salts, or precipitation of naturally occurring metals in soils.	H/WQMM-1: Develop storm water pollution prevent plans. H/WQMM-2: Water Quality Monitoring H/WQMM-3: Develop site specific remedial action plans that take site characteristics including, geology, hydrology, environmental setting, and on-site and nearby structures into account. Ensure proper design, siting, and operational timing to reduce alterations of natural hydrology and adverse effects on stream and groundwater quality and quality from structural compliance measures. • Install and maintain erosion control measures (e.g. waterbars, rolling dips, mulch, rock rip-rap) to prevent discharge of excess sediment from soil disturbing activities. • Relocate roads away from unstable and landslide prone terrain. Drain roads away from unstable areas during construction, reconstruction of maintenance activities. Locate new roads on stable ground to the maximum extent practicable. • Minimize cutbank height and avoid placement of fill on steep slopes. Use off-channel water collection features for dust abatement purposes. • Install adequate number/type of road drainage features to prevent concentration of road runoff. • Seek professional (e.g. Natural Resources Conservation Service, local resource conservation district) in developing land management plans and observational techniques to ensure optimal stocking rates for rangelands. • Protect drainage channels from sediment contributions with	Less than Significant with Mitigation

TABLE 5-1 WATER QUALITY OBJECTIVE UPDATE AMENDMENT CEQA REQUIREMENTS POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES				
Compliance Measures	Environmental Factor	Potential Environmental Impact	Mitigation Measure	Level of Significance
Aquatic Ecosystem Restoration Erosion and sediment control Measures to address tailwater and surface water impoundments Preservation of existing cold water resources Measures to Restore and Maintain Stream Flows		Reduction in stream flows due to the increase in evapotranspiration from increased riparian tree retention. Temporary sediment discharges that exceed water quality objectives from construction and/or restoration activities. Excessive use of rip-rap or stream stabilization structures intended to beneficially affect flow could alter conditions downstream. Work within and adjacent to waters increases the risk of leaking equipment or hazardous material spills, short term turbidity increases and/or discharges of settable solids. Breaching lakeshore levees to create diverse habitat features and lower lake levees to create riparian fringe habitat has the potential to adversely affect hydrology and natural flow patterns. Operations of aeration systems for DO have the potential to supersaturate conditions, exceed water quality standards and lead to accelerated mortality rates of salmoninds. Decrease stream flows and/or aquifer storage from dust abatement. Alterations of natural hydrology and increases in stream temperatures by concentrating or redirecting road runoff. Increased risk of soil or groundwater contamination with concentrated minerals, salts, or persistent pesticides. Increased risk of erosion and sedimentation from the construction of trails, stream crossings, and riparian grazing. Increase risk of groundwater contamination of petroleum hydrocarbons and metals from the infiltration of storm water runoff	vegetated buffers, wattles or similar erosion control devices. • Plant a cover crop on exposed soil to reduce the length of time in which soil is exposed to wind and water. Cover exposed soil that will not receive immediate planting with straw or other suitable erosion control material. • Use precision (site specific) farming techniques; monitor chemical condition of soil, water, and plant residuals carefully prior to applying fertilizers, pesticides, or water, including tailwater. • Leach soils within the root zone as necessary to prevent salt build up in that portion of the soil profile. • Avoid introduction of storm water into tailwater system to prevent impacts to storm water. • Maintain filter strips between fields and surface water to prevent discharge of tailwater directly into surface waters. • Don't concentrate drainage such that toxic levels of constituents are discharge to waters. H/WQMM-4: Implement flow rate modeling, monitoring, prohibitions and restrictions within specific Regional Water Board permits and orders. H/WQMM-5: Plant native vegetation that has evolved with the natural environment. Allow for the removal or thinning of upland vegetation that has high evapotranspiration rates and increases fire risks. USSMM-3: Plan for and develop conservation and efficiency projects for water supply. Plan for and develop recycled water projects and aquifer storage and recovery (ASR) projects.	
Construction, installation, and operation of soil/groundwater remediation facilities	Land Use Planning	Installation or expansion of remediation or treatment facilities may have a potential for direct and indirect impacts to a candidate, sensitive, or special status species or their habitat and could conflict with applicable conservation plans.	BRMM-1: Consult the applicable state and federal resource protection agencies BRMM-2: Delineate and avoid any project specific environmental sensitive areas.	Less than Significant with Mitigation

TABLE 5-1 WATER QUALITY OBJECTIVE UPDATE AMENDMENT CEQA REQUIREMENTS POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES				
Compliance Measures	Environmental Factor	Potential Environmental Impact	Mitigation Measure	Level of Significance
Preserve, maintain, and restore site specific potential shade Preservation of existing cold water resources Measures to Restore and Maintain Stream Flows		Reliance on alternative water sources, water conservation efforts, and preservation of areas of known thermal refugia could have a conflict with local plans or ordinances that call for an increase through various water supply and/or development projects. Municipal, domestic, agricultural and industrial water supply could be impacted by certain restrictions on the extraction of water from riparian areas or areas of known thermal refugia. Construction or expansion of off-stream water storage facilities could conflict with local plans or ordinances. The groundwater toxicity objective could present a conflict with groundwater management strategies such as aquifer storage and recovery	BRMM-3: Species specific work windows to avoid contact or disturbances. BRMM-4: Compensatory mitigation to create, replace, or restore filled or modified waters of the U.S. (streams and wetlands). BRMM-5: Remedial action plans proposing phytoremediation would need to evaluate the potential for bioaccumulation of toxic compounds and select plans species that will not become primary producers in the food chain. H/WQMM-1: Develop storm water pollution prevent plans. H/WQMM-2 Water Quality Monitoring H/WQMM-3: Develop project specific remedial action plans that take site characteristics including, geology, hydrology, environmental setting, and on-site and nearby structures into account. Ensure proper design, siting, and operational timing to reduce alterations of natural hydrology and adverse effects on stream and groundwater quality and quality from structural compliance measures. USSMM-3: Plan for and develop conservation and efficiency projects for water supply. Plan for and develop recycled water projects and aquifer storage and recovery (ASR) projects.	
Construction, installation, and operation of soil/groundwater remediation, wastewater treatment facilities, and variable outlet structures Upgrade or expansion of waste water treatment facilities Excavation	Noise	Temporary increases in noise from heavy equipment during compliance measures installation or upgrade. Temporary increase in noise from trucks and heavy equipment during excavations Temporary increase in noise from drill rigs installing monitoring wells, injection wells, or extraction wells. Use of pumps, mixers, and compressors to sample, remediate and treat water. Use of thermal treatment units/incineration can produce noise above ambient levels. Construction, modification or removal of facilities for the purpose of groundwater or surface water extraction, energy supply and/or recreation	NOMM-1: Noise Control Plans • Decibel monitoring • Peak noise working hours • Evening working hours • Equipment inspection • Muffler inspections • Nearby receptors • Compliant process plan • Operations contingency plan NOMM-2: Advanced notifications NOMM-3: Sound control structures NOMM-4: Equipment buffer	Less than Significant with Mitigation

TABLE 5-1
WATER QUALITY OBJECTIVE UPDATE AMENDMENT
CEQA REQUIREMENTS
POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Compliance Measures	Environmental Factor	Potential Environmental Impact	Mitigation Measure	Level of Significance
Physical barriers Reservoir or stream aeration structures Aquatic Ecosystem Restoration Erosion and sediment control Measures to address tailwater and surface water impoundments Preservation of existing cold water resources Measures to Restore and Maintain Stream Flows		could result in short term and long term impacts from noise. Permanent increases in noise from wastewater treatment facility upgrades, or from decade-long cleanup projects.		
Preserve, maintain, and restore site specific potential effective shade Aquatic Ecosystem Restoration Measures to Restore and Maintain Stream Flows	Public Services	Retaining and preserving riparian areas can lead to increases in forest fires leading to an increase demand on fire services.	H/WQMM-1: Storm Water Pollution Prevent Plans H/WQMM-3: Develop site specific remedial action plans that take site characteristics including, geology, hydrology, environmental setting, and on-site and nearby structures into account. H/WQMM-5: Plant native vegetation that has evolved with the natural environment. Allow for the removal or thinning of upland vegetation that has high evapotranspiration rates and increases fire risks.	Less than Significant with Mitigation
Erosion and sediment control		Increased enforcement on sediment discharges from illegal cultivations could lead to an increased demand in local, state and federal law enforcement resources. Increase burden on vector control from wetland creation and sediment	Not applicable	Less than Significant

TABLE 5-1 WATER QUALITY OBJECTIVE UPDATE AMENDMENT CEQA REQUIREMENTS POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES				
Compliance Measures	Environmental Factor	Potential Environmental Impact	Mitigation Measure	Level of Significance
		control basins.		
Construction, installation, and operation of soil/groundwater remediation facilities Upgrade or expansion of waste water treatment facilities Well installation Excavation Physical barriers Settling ponds Preserve, maintain, and restore site specific potential effective shade Aquatic Ecosystem Restoration Erosion and sediment control Measures to address tailwater and surface water impoundments Preservation of existing cold water resources	Transportation and Traffic	Temporary increase in truck traffic from the construction or expansion of a remediation or treatment system. Temporary increase in traffic from lane closures due to subsurface investigations. Temporary increase in traffic from excavation activities. Increased tree retention may conflict with transportation agencies (public roads) site distance requirements and areas designated as clear recovery zones. Short term traffic increases associated with sediment reduction project, construction projects, dam removal, stream and/or riparian restoration. A reduction in water resource availability could lead to agricultural land conversion, which in turn could lead to increased development and traffic.	TTMM-1: Traffic Control Plans • Signage locations • Through traffic routes • Designated truck routes • Construction site access • Designated work and staging areas • Parking areas • Pedestrian and bicycle safety access • Detours and lane closures • Emergency access routes and detours • Flaggers TTMM-2: Night Work TTMM-3: Strategic planning and design to avoid and minimize the placement of facilities that have site distance conflicts. Case-by-case evaluations of site distance. BRMM-4: Compensatory mitigation to create, replace, or restore filled or modified waters of the U.S. (streams and wetlands).	Less than Significant with Mitigation

TABLE 5-1 WATER QUALITY OBJECTIVE UPDATE AMENDMENT CEQA REQUIREMENTS POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES				
Compliance Measures	Environmental Factor	Potential Environmental Impact	Mitigation Measure	Level of Significance
Upgrade or expansion of waste water treatment facilities Construction, installation, and operation of soil/groundwater remediation facilities Measures to address tailwater and surface water impoundments Measures to Restore and Maintain Stream Flows	Utilities and Service Systems	Construction or demolition of facilities could result in short term interruption of utilities such as sewer, water, gas, electricity, phone, or internet. Dam removal, water conservation and/or reliance on alternative water sources could lead to short term interruptions and could lead to a decrease in available water supply and landfill capacity.	USSMM-1: Coordinate with the underground service alert system, and utility providers to develop project specific plans to avoid and minimize any potential utility interruptions. USSMM-2: Develop waste management plans for dam removal projects. Coordinate with prospective landfills regarding the estimated amount of waste generated by a proposed project and landfill capacity. USSMM-3: Plan for and develop conservation and efficiency projects for water supply. Plan for and develop recycled water projects and aquifer storage and recovery (ASR) projects.	Less than Significant with Mitigation

6 Economic Consideration

The Regional Water Boards are legally required to consider economics in the development of water quality objectives[1]. The triggers for Regional Water Board consideration of economics or costs in basin planning include:

- Establishing water quality objectives that ensure the reasonable protection of beneficial uses.
- Compliance with the California Environmental Quality Act (CEQA)[2] when Boards amend their basin plans. CEQA, and the regulations implementing CEQA, require that the Boards analyze the reasonably foreseeable methods of compliance with proposed performance standards and treatment requirements.[3] This analysis must include economic factors.

Chapter 5 is the analysis of potential environmental impacts, as required under CEQA, associated with adopting an amendment to the Water Quality Control Plan for the North Coast Region (Basin Plan) to update water quality objectives. Chapter 5 contains the reasonably foreseeable compliance measures necessary to achieve compliance with the draft water quality objectives for dissolved oxygen (DO) for surface waters, chemical constituents for surface waters and groundwater, and toxicity for groundwater. Compliance measures include treatment technologies and methods and management practices most likely to be implemented to achieve compliance with water quality objectives.

6.1 Scope of the Economic Considerations

What follows is an estimate of the costs associated with compliance measures. The costs are given as a range, dependent on the specific characteristics of the land or operation to which given management practices are applied. A list of potential funding sources is also given.

The Regional Water Boards are required to consider economics when developing water quality objectives; however, a Regional Water Board is not obligated to consider the balance of costs and benefits associated with implementation of a Basin Plan amendment. They are obligated to consider the costs of compliance and potential sources of funding and may adopt Basin Plan amendment even if the costs are considered to be significant[4]. For CEQA purposes, the economic and social impacts of the proposed project are considered to determine if they will cause or contribute to an adverse environmental impact, not whether the costs of the measures themselves are significant or will cause an economic hardship. In the case of prospectively incorporating Maximum Contaminant Levels (MCLs) adopted by the California Department of Public Health (now the State Water Board Division of

[1] See Wat. Code, § 13240-13247
[2] Pub. Resources Code § 21000 *et seq.*
[3] Cal.Code Regs., tit., 23 § 3777 subdivision (b).
[4] See *California Assn. of Sanitation Agencies v. State Water Resources Control Board* (2012) 208 Cal.App. 4th 1438, 1466.

Drinking Water), economic considerations were (or will have been) taken into account during the adoption or revision of those numbers. For example, engineering costs and the technical feasibility of implementation of the best available technologies (BAT) were evaluated. Therefore, MCLs are incorporated into the Basin Plan with an existing economic analysis sufficient for the purpose of complying with Water Code section 13241. This chapter estimates only the cost of compliance measures for the purpose of adopting a new groundwater toxicity objective and revising the existing objectives for DO and chemical constituents. The scope of this analysis covers the potential costs associated with implementation of compliance measures without considering whether compliance measures are currently part of the existing regulatory baseline.

6.1.1 Methodology

The majority of costs identified in this chapter were derived from the following sources of information including:

- U.S. Environmental Protection Agency (USEPA):
    - USEPA Technology Fact Sheets http://water.epa.gov/scitech/wastetech/mtbfact.cfm
    - USEPA Technologies and Costs for Removal of Arsenic from Drinking Water http://water.epa.gov/drink/info/arsenic/upload/2005_11_10_arsenic_treatments_and_costs.pdf
    - USEPA Wastewater Technology Fact Sheet Free Water Surface Wetlands & Constructed Wetland Treatment of Municipal Wastewaters http://water.epa.gov/infrastructure/septic/upload/free_water_surface_wetlands.pdf
- State Water Resources Control Board (State Water Board) Underground Storage Tanks Cleanup Fund (UST Fund) http://www.waterboards.ca.gov/water_issues/programs/ustcf/;
- California Department of Public Health Division of Drinking Water, now the State Water Board Division of Drinking Water (DDW) http://www.waterboards.ca.gov/drinking_water/programs/index.shtml;
- Addressing Nitrate in California's Drinking Water Technical Report 5: Groundwater Remediation and Management for Nitrate http://groundwaternitrate.ucdavis.edu/;
- Federal Remediation Technologies Roundtable Screening Matrix and Reference Guide (FRTR) http://www.frtr.gov/default.htm;
- Natural Resource Conservation Service (NRCS) Field Office Technical Guide (FOTG) http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/fotg/;
- California Department of Fish and Wildlife (CDFW) Salmonid Stream Habitat Restoration Manual http://www.dfg.ca.gov/fish/Resources/HabitatManual.asp;
- CDFW Coho Salmon Recovery Strategy http://www.dfg.ca.gov/fish/Resources/Coho/CohoRecovery.asp; and
- California Department of Transportation (Caltrans) 2013 contract proposal award information http://www.dot.ca.gov/hq/esc/oe/project_ads_addenda/.

The cost information provided in the USEPA guidance and FRTR are available to assist publicly owned treatment works (POTWs) and parties responsible for remediation in understanding the necessary components and costs involved with implementing particular technologies. Many of the cost breakdowns are based on a variety of example sites throughout the county over the last two decades. Therefore, it can be generally assumed that these costs have increased with inflation, although some compliance measures have become more affordable as improvements in technologies are made.

The cost information provided in the NRCS FOTG is a national dataset to assist local NRCS Districts in setting cost shares for implementing conservation practices. Cost estimates are provided at the county level and the data used for this analysis are specific to Northern California (including Del Norte, Humboldt, Trinity, Siskiyou, Mendocino and Sonoma Counties), as described in their Fiscal Year 2013 Payment Schedule. The FOTG represents the NRCS estimate of costs to implement such practices.

The costs included in the CDFG Manual are described as upslope erosion inventory and sediment control guidance. The numbers are based on estimates provided by Pacific Watershed Associates, a consulting firm specializing in erosion control work. Actual costs can vary considerably depending on operator skill and experience, equipment types, local site conditions, and regional location.

6.1.2 Existing Requirements

The costs of the compliance measures present a range of full scale implementation. However, the existing regulatory baseline already requires many of these measures to be in place and occasionally upgraded as advances in BAT are achieved and made more economically feasible to implement. For example, many waste water treatment plant operations undergo facility upgrades to achieve compliance with existing water quality objectives for chemical constituents and toxicity. Likewise, existing facilities such as hydropower dams in the region have undergone or are currently evaluating methods and measures by which compliance with the existing dissolved oxygen objectives may be met. Additionally, groundwater remediation actions currently being implemented in accordance with existing regulatory programs often require multiple layers of assessment, monitoring and corrective actions to reach compliance with existing objectives. Therefore, the full or total cost of a compliance measure may exceed the cost associated with the draft revision of the water quality objectives. In fact, the cost associated with revisions of the water quality objectives in most cases will be a fraction of the total cost of compliance, if there is any additional cost at all.

Landowners and project proponents are bound by various existing regulatory requirements that involve water quality and natural resource protection. The economic impact of existing obligations (baseline) should not be attributed as costs of compliance with the proposed Basin Plan amendment. Limiting the scope of the economic analysis is difficult given the similarity of measures necessary to achieve a wide range of water quality and wildlife protection goals. To remain as focused as possible, this economic analysis only contemplates the costs of measures identified as 'reasonably foreseeable' (see Chapter 5). However, if taken as a whole, they are likely an overestimate of the actual costs of compliance. This is because of the multiple and overlapping regulatory programs under which the same measures are reasonably foreseeable.

For example, some chemical or dissolved oxygen control costs are related to actions necessary to avoid violations of the existing discharge prohibitions in the Basin Plan or to avoid 'taking' of a species under the Endangered Species Act or to fully mitigate impacts of authorized 'takes'. Other costs may be incurred as a result of compliance with the Clean Water Act (CWA), other related statutes and regulations, or local land use ordinances. Conversely, compliance with the draft water quality objectives will help dischargers comply with the other regulatory requirements.

6.1.3 Geographic Scope

The implementation actions necessary for compliance with the draft Basin Plan amendment are not uniformly required across the North Coast Region or even across properties with similar land uses. Instead, many of the implementation actions will be required of landowners/project proponents on an as-needed and project-specific basis. While the objectives themselves uniformly exist, the relevant beneficial uses being protected and site characteristics affecting the implementation of compliance measures vary across the region.

6.2 Costs of Compliance Measures to Address Water Quality Objectives for Chemical Constituents and Toxicity in Surface Waters and Groundwaters

6.2.1 Potential Costs for Groundwater Remediation

The cost of remediating groundwater includes:

- Cost of characterizing the groundwater aquifer in terms of contaminants present, horizontal and vertical extent of contamination, and the hydrogeology underlying the site.
- Capital costs of remediation systems including design, permitting and construction.
- Operation and maintenance cost during the life of the project; which may be longer with more stringent water quality objectives.

General Monitoring and Assessment Compliance Measures[5]

- Monitoring Well Installation – 3 wells to 30 feet deep = $12,604 / 6 wells to 50 feet deep = $33,012
- On-site Storage Areas – $528 / month

[5] SWRCB USTCF Cost Guidelines

- Traffic Control Plans – $462 - $1,254 per event
- Health and Safety Plans – $1,264
- Work Plans - $1,742 to $3,069

Table 6-1
Estimated Cost Ranges for Soil and Groundwater Remediation Compliance Measures

Compliance Measures	Range of Practice Costs for Small Site 500-10,000 ft² / 500-10,000 cy/ <10,000s gallons per year	Range of Practice Costs for Large Site 10,000-2,000,000 ft² / 10,000-50,000 cy / >10,000s gallons per year	Cost Source
In-Situ Biological Remediation			
Bioventing	$26 to $27/ ft² $710 to $742 /cy	$2 to $3 / ft² $60 to $94 /cy	FRTR
Bioreactor Landfills	$143 to $167 per thousand gallons	$21 to $36 per ten thousand gallons	FRTR
Enhanced Biodegradation	Oxygen enhancement $40 to $80 per 1,000 gallons Nitrate enhanced treatment $160 to $230 per gallon		FRTR
Phytoremediation	$480 to $1,800 /cy $1.52 to $1.69 / ft²	$150 to $485 /cy $0.45 to $0.64 / ft²	FRTR
Natural Attenuation	$40,000 to $60,000 per site includes site assessment and year of monitoring	$100,000 to $750,000 includes site assessment and 5-10 yrs of monitoring	FRTR, USTCF
In-Situ Physical/Chemical Remediation			
Chemical Oxidation	$71 to $100 /cy $0.02 / gallon $156 to $175 / 10,000 gallons	$71 to $100 /cy $0.004 / gallon $31 to $39 / 10,000 gallons	FRTR, USEPA[2]
Electrokinetic Separation	$20 to $225 /cy		FRTR, GWRTAC
Fracturing	$1,000 to $1,500 includes four to six fractures per day.		FRTR
Soil Flushing	$32 to $49 /cy	$18 to $27 /cy	FRTR
Soil Vapor Extraction	$944 to $1,100/ cy	$300 to $722/ cy	FRTR
Air Sparging	$28 to $64/cy	$18 to $20/cy	FRTR
Air Stripping	$0.002 to $0.0021/ gallon $20 to $34 / 10,000 gallons	$0.004 to $0.005/ gallon $4 to $5 / 10,000 gallons	FRTR
BioSlurping / Dual Phase Extraction	$56/ gallon $25 to $55 /cy $10,000 to $12,000 per week	$56/ gallon $23 to $52 /cy $10,000 to $125,000 per year	FRTR
Directional Wells	$20 to $100 / ft		FRTR, USTCF
Permeable Reactive Barriers / Treatment Walls	Trenching >=30 ft bsg $2 to $10 /ft² Trenching >=80 ft bsg $2 to $55+ /ft² Reactive media $0.30-$1.25 /lb $963 to $1,961 /cy of treatment wall $0.13 to $0.21 /cy of groundwater treated		ITRC, USTCF, FRTR
Thermal Treatment	$32 to $300 /cy		FRTR

Table 6-1
Estimated Cost Ranges for Soil and Groundwater Remediation Compliance Measures

Compliance Measures	Range of Practice Costs for Small Site 500-10,000 ft^2 / 500-10,000 cy/ <10,000s gallons per year	Range of Practice Costs for Large Site 10,000-2,000,000 ft^2 / 10,000-50,000 cy / >10,000s gallons per year	Cost Source
Ex-Situ Biological Remediation Compliance Measures			
Biopiles	$30 to $60 /cy		FRTR
Composting	$489 to $578 /cy	$481 to $555 /cy	FRTR
Land Farming	Pre-treatment capital costs $25,000 to $50, 000 Treatment cost <=$75 /cy		FRTR
Slurry Phase	$100 to $160 /cy		FRTR
Bioreactors	$143 to $167 per thousand gallons	$21 to $36 per ten thousand gallons	FRTR
Constructed Wetlands	$0.45 to $1.36 /1,000 gallons over 10 to 30 year timeframe Pre-treatment capital $359,000 to $1,015,009 /acre of wetland treatment system Operations and maintenance costs $5,00 to $8,323 /acre per year		FRTR, USEPA[3]
Ex-Situ Physical/Chemical Remediation Compliance Measures			
Chemical Reduction	$42 to $500 /cy		FRTR, USEPA[2]
De-halogenation/ De-chlorination / Reductive Treatment	$200 to $500 /ton $1.20 to $6.30 /1,000 gallons treated (pump & treat GAC) $0.10 to $10.00/1,000 gallons treated		FRTR, USEPA[1], USEPA[2]
Separation / Soil washing	$53 to $142 /cy $1.38 to $4.56 /1,000 gallons treated		FRTR
Activated Carbon Treatment	$0.80 to $6.30 /1,000 gallons treated		FRTR, GWRMN
Advanced Oxidation	$0.10 to $10 /1,000 gallons treated		FRTR, AFCEE
Air Sparging	$28 to $64/cy	$18 to $20/cy	FRTR
Air Stripping	$0.002 to $0.0021/ gallon $20 to $34 / 10,000 gallons	$0.004 to $0.005/ gallon $4 to $5 / 10,000 gallons	FRTR
Excavation/ Dredging and Disposal	$12 to $500 /ton $5 to $300 /cy		FRTR, USEPA[3], USTCF
Groundwater Pumping /Extraction, Treatment & Disposal	See costs for bioreactors, constructed wetlands, adsorption, air stripping, activated carbon treatment, oxidation, dual phase extraction, Air Stripping, De-halogenation/ De-chlorination / Reductive Treatment and ion exchange.		FRTR, USEPA[1], USEPA[2], USTCF
Ion Exchange / Electrodialysis	$0.30 to $1.23 /1,000 gallons treated	$254k to $2.1 million / 1.1 to 12.3 mgd	FRTR, GWRTAC, USEPA[2], GWRMN
Reverse Osmosis	$5.75 to $16.64 /10,000 gallons treated	$776k to $81 million / 1.0 to 200 mgd	WESC, GWRMN, USEPA[2],

Table 6-1
Estimated Cost Ranges for Soil and Groundwater Remediation Compliance Measures

Compliance Measures	Range of Practice Costs for Small Site 500-10,000 ft^2 / 500-10,000 cy/ <10,000s gallons per year	Range of Practice Costs for Large Site 10,000-2,000,000 ft^2 / 10,000-50,000 cy / >10,000s gallons per year	Cost Source
Precipitation/ Coagulation/ Flocculation/ Sedimentation (including lime softening)	$17 to $41 /<=10,000 gallons treated	$91k to $9.1 million / 0.7 to 135 mgd	FRTR, USEPA[1], USEPA[2]
Ex-Situ Thermal Remediation Compliance Measures			
Incineration	$796 to $1,171 /cy	$695 to $1,063 /cy	FRTR
Pyrolysis	$300 /ton		FRTR
Thermal Desorption	$75 to $232 / cy	$40 to $101 / cy	FRTR
Contamination Containment Compliance Measures			
Landfill Cap	$175k to $225K / acre		FRTR
Physical Barriers	$5 to $7 / ft^2 Trenching >=30 ft bsg $2 to $10 /$ft^2$ Trenching >=80 ft bsg $2 to $55+ /$ft^2$ Reactive media $0.30-$1.25 /lb $963 to $1,961 /cy of treatment wall $0.13 to $0.21 /cy of groundwater treated		ITRC, USTCF, FRTR

ft- feet
ft^2 – feet squared
cy – cubic yard
bsg – below surface grade
lb – pound
mgd- million gallons per day
FRTR – Federal Remediation Technologies Roundtable
GWRTAC – Groundwater Remediation Technologies Analysis Center, Technology Overview Report TO-97-03
USTCF – State Water Resources Control Board Underground Storage Tank Cleanup Fund
USEPA 1 – US Environmental Protection Agency Technology Fact Sheets http://water.epa.gov/scitech/wastetech/mtbfact.cfm
USEPA 2 – US Environmental Protection Agency Technologies and Cost for Removal of Arsenic from Drinking Water
USEPA 3 – US Environmental Protection Agency Technology Fact Sheet Free Surface Water Wetland & Constructed Wetland Treatment of Municipal Wastewaters
GWRMN- Groundwater Remediation and Management for Nitrate Report – Addressing Nitrate in California's Drinking Water Technical Report 5
AFCEE – AFCEE Technology Transfer Workshop; InSitu Chemical Oxidation, R. Brown, Ph.D
WESC – Williams Engineering Services Company, Inc. – A Review of Wastewater Treatment by Reverse Osmosis
ITRC - Interstate Technology & Regulatory Council – Permeable Reactive Barrier: Technology Update

6.2.2 Potential Costs for Wastewater Treatment

The cost of treating and discharging wastewater includes capital costs and operations and maintenance.

Table 6-2
Estimated Cost Range for Wastewater Treatment Compliance Measures

Compliance Measures	Capital Costs	Annual O&M Costs	Cost Source
Wastewater Disinfection Compliance Measures			
Chlorine	1-2.5 mgd = $1.1 to $1.3 million 10-20 mgd = $3.1 to $4 million 100-175 mgd = $14.3 to $1.3 million	1-2.5 mgd = $49K to $76K 10-20 mgd = $158K to $380K 100-175 mgd = $660K to $1.3 million	USEPA[1]
Ozone	Oxygen gas /compressor $245K Contact vessel (500 gpm) $4,000 - $5,000 Destruct unit: Small (around 30 cfm) $800 Large (around 120) $1,000-1,200 Non-component costs $35,000 Engineering $12,000-15,000 Contingencies 30%	Labor $12,000 Power 90 kW Other (filter replacements, compressor oil, spare dielectric, etc.) $6,500	USEPA[1]
Ultraviolet	Lamps 1-5 mgd =$400-$1,375 5-10 mgd = $345-$595 19-100 mgd = $275-$590 Systems $245k	$19,200	USEPA[1]
Decentralized Systems Technology			
Septic System	$2,500 to $4,500		USEPA[1], EN
Aerobic Treatment	500 - 1,500 gpd = $2,500 to $9,000	$350	USEPA[1]
Control Panels	$1,500 - $3,000 /unit		USEPA[1]
Sand/Gravel Filters	Range $4,000 - $15,000 1,500-gallon single compartment septic/pump tank @ $0.57/gallon = $850 ISF complete equipment package (includes dual simplex panel, pump pkg., tank risers, lids, liner, lateral kit, orifice shields, etc.) = $3,200 Non-component costs = $750	Labor @ $65/hr. (2 hrs./yr.)= $130 Power @10 cents/kWh Sludge disposal=$25	USEPA[1], EN

Table 6-2
Estimated Cost Range for Wastewater Treatment Compliance Measures

Compliance Measures	Capital Costs	Annual O&M Costs	Cost Source
	Engineering (soil evaluation, siting, design, and construction)= $2,000 Contingencies (permit fees)= $1,000 Land may vary		
Low Pressure Pipe System	$1,500 - $5,000		USEPA[1], EN
Pressure Systems	$4,000 - $6,500		USEPA[1], EN
Mound Systems	$9,000 to $20,000		USEPA[1], EN
Wastewater Treatment Compliance Measures			
Aerated/ Partial Mix Lagoons	Excavation =$12 to $500 /ton $5 to $300 /cy Compaction = $3 to $5/cy Synthetic lining = $0.5 to $1/$ft^2$		USEPA[1]
Advanced Ecologically Engineered Systems	40K gpd = $985K to $1.2 million 80K gpd = $1.5 to $1.9 million 1 million gpd = $8.5 to $10.5 million		USEPA[1]
Ballasted Flocculation	$91 /million gallons treated		USEPA[1]
Chemical Precipitation	Chemical Cost/lb Treatment Cost/gal Ferrous sulfate $0.17 $1.03 Dithiocarbamate $0.95 $0.82 Borohydride $2.86 $0.76 Aluminum $0.50 $0.04		FRTR, USEPA[1], USEPA[2]
Granular Activated Carbon Absorption	$0.80 to $6.30 /1,000 gallons treated	Carbon $0.50 to $1.20 /lb	USEPA[1]
Dechlorination	$6,500 to $383,000	$9,900 to $17,500 $0.10 to $10.00/1,000 gallons treated	USEPA[1],
Denitrifying Filters	$241,000 to $26,520,000 $1.0/lb of total nitrogen removed $0.58/gpd capacity	$7,050 to $841,000 $0.51/lb nitrogen removed	USEPA[1], GWRMN
Ion Exchange / Electrodialysis	$240 to $400 /square meter of membrane	$0.30 to $1.23 /1,000 gallons treated $254k to $2.1 million / 1.1 to 12.3 mgd	FRTR, GWRTAC, USEPA[2], GWRMN

Table 6-2
Estimated Cost Range for Wastewater Treatment Compliance Measures

Compliance Measures	Capital Costs	Annual O&M Costs	Cost Source
Chemical reduction	Aluminum sulfate, liquid, in tanks, iron-free $269/ton Aluminum sulfate, liquid, in tanks, NOT iron-free $152/ton Aluminum sulfate, dry, 100 lb bags, iron-free $250/ton Aluminum sulfate, dry, 100 lb bags, NOT iron-free $245 - $280/ton Ferric chloride, technical grade, in tanks $255 - $300/ton Ferrous sulfate, monohydrate, granulated, bulk $223 - $240/ton Lime, chemical, hydrated, bulk $70/ton	Ferrous sulfate $1.03/ gallon treated Dithiocarbamate $0.82/ gallon treated Borohydride $0.76/ gallon treated Aluminum $0.04/ gallon treated $91k to $9.1 million / 0.7 to 135 mgd treated	FRTR, USEPA[1], USEPA[2], GWRTAC,
Wetland Treatment Systems	$155,000 to $260,00 /100,000 gpd $359,000 to $1,015,009 /acre of wetland treatment system Operations and maintenance costs	$5,00 to $8,323 /acre per year $0.45 to $1.36 /1,000 gallons over 10 to 30 year timeframe	FRTR, USEPA[3]
Membrane Bioreactors	$7.00-$20.00 / gpd capacity	$1.00-$2.00 /gallons treated	USEPA[1], GWRMN
Oxidation Ditches	$2.50-$4.00 / gpd	$2.00-$12.00 / gpd treated	USEPA[1]
Package Plants	$4.00-$6.00 /gallons treated	$800-$2,000 /millions gallons treated	USEPA[1]
Reverse Osmosis	$776k to $81 million / 1.0 to 200 mgd		USEPA[1]

gpm – gallons per minute / mgd – million gallons per day / gpd – gallons per day/ cy – cubic yard / ft^2 – square foot / lb – pound / ft- feet
FRTR – Federal Remediation Technologies Roundtable
GWRTAC – Groundwater Remediation Technologies Analysis Center, Technology Overview Report TO-97-03
USTCF – State Water Resources Control Board Underground Storage Tank Cleanup Fund
USEPA 1 – US Environmental Protection Agency Technology Fact Sheets http://water.epa.gov/scitech/wastetech/mtbfact.cfm
USEPA 2 – US Environmental Protection Agency Technologies and Cost for Removal of Arsenic from Drinking Water
USEPA 3 – US Environmental Protection Agency Technology Fact Sheet Free Surface Water Wetland & Constructed Wetland Treatment of Municipal Wastewaters
GWRMN- Groundwater Remediation and Management for Nitrate Report – Addressing Nitrate in California's Drinking Water AFCEE – AFCEE Technology Transfer Workshop; InSitu Chemical Oxidation, R. Brown, Ph.D
WESC – Williams Engineering Services Company, Inc. – A Review of Wastewater Treatment by Reverse Osmosis
ITRC - Interstate Technology & Regulatory Council – Permeable Reactive Barrier: Technology Update
EN- Eco-Nomic Septic System design Page http://www.eco-nomic.com/indexsdd.htm#Industrial or Non-Residential Wastewater

6.3 Costs of Compliance Measures to Address the Water Quality Objective for Dissolved Oxygen in Surface Waters

The following activities influence the presence of DO in an aquatic system: agricultural practices, forestry practices, fossil fuel extraction and refinement practices, other mining practices, construction practices, residential and commercial practices, recreational practices, and industrial practices. These activities have the potential to act as sources of: animal wastes, mining wastes, septic system leachate, landfill leachate, fertilizers, sewage treatment plant effluent, industrial effluent, industrial emissions, vehicle emissions, storm water discharge, fire ash and smoke, and other historic or existing sources. In addition, these activities have the potential to alter environmental conditions in such a way as to alter the natural cycle of DO availability. For example, the installation of impoundments, alteration of land cover, alteration of the stream channel, increase in temperature, or increase in sediment delivery can impact or alter the natural pattern and range of DO in an aquatic system. See Chapter 2 of this Staff Report, for more details on land uses that affect DO and the existing regulatory programs in place.

<u>Timber</u>

Timber harvest activities can substantially impact water temperature. Timber harvest on non-federal lands is currently regulated by the Regional Water Board through a combination of general WDRs and conditional waivers of WDRs. The costs associated with WDRs are not outlined here as they are a current requirement. Roads that are part of a timber harvest plan or Non-Industrial Timber Management Plan (NTMP) are required by the WDRs and waivers for timber harvest on nonfederal lands to implement an erosion control plan. Additional costs to timber operators associated with the draft WQO Update Amendment could come from the additional retention of trees above the existing requirements in certain areas. Therefore, the additional retention of trees could potentially be foregone revenue. However, due to the broad range of potential factors including site potential, topography, existing requirements, and amount of timber available the specific costs are too complex to estimate. Typical categories of compliance for timber operations include maintaining and preserving site potential shade, controlling erosion and sediment, preserving existing cold water resources, and aquatic ecosystem restoration.

<u>Roads</u>

The road networks in the North Coast Region contribute to elevated sediment loads and temperatures in tributary watersheds through the discharge of excess sediment. In some cases, an inventory of roads will determine that decommissioning or upgrading of roads is required.

Regardless of the method of regulation or the responsible party, the requirements for controlling sources of sediment from roads are similar and implementation will potentially focus on the following process:

1. Inventory: Identify sources of excess sediment discharge or threatened discharge and quantify the discharge or threatened discharge from the source(s).
2. Prioritize: Prioritize efforts to control discharge of excess sediment based on, but not limited to, severity of threat to water quality and beneficial uses, the feasibility of source control, and source site accessibility.
3. Implement: Develop and implement feasible sediment control practices to prevent, minimize, and control the discharge. Road decommissioning may be required as part of a responsible parties' load allocation if maintaining the road is cost prohibitive, the road is not needed or is a source of uncontrollable excess sediment discharge.
4. Monitor and Adapt: Use monitoring results to direct adaptive management in order to refine excess sediment control practices and implementation schedules until discharges are reduced to a level that meets any applicable TMDL load allocations and water quality standards.

Typical categories of compliance for roads include maintaining and preserving site potential shade, controlling erosion and sediment delivery, preserving existing cold water resources, and aquatic ecosystem restoration.

Irrigated Agriculture

Irrigated agriculture occurs throughout the North Coast Region and is predominantly concentrated in: 1) the Tule Lake region in Siskiyou and Modoc Counties; 2) the Scott Valley, Shasta Valley, and upper Klamath River Valley in Siskiyou County; 3) Round Valley, Potter Valley, Eden Valley, Anderson Valley and the upper Russian River Valley in Mendocino County; and 4) Alexander Valley, Dry Creek Valley, Russian River Valley Below Dry Creek and the Laguna de Santa Rosa in Sonoma County. Principal irrigated crops are barley, irrigated pasture, alfalfa hay and other hay, oats, potatoes, wheat and grapes. For most of the management practices, a range of costs is given, depending on numerous project-specific factors to be determined by landowners/dischargers. Typical categories of compliance for irrigated agriculture include maintaining and preserving site potential shade, controlling erosion and sediment delivery, addressing tailwater and surface water impoundments, preserving existing cold water resources, aquatic ecosystem restoration, and actions to restore or maintain stream flows to support all beneficial uses. Costs to the irrigated agricultural community to comply with the draft Basin Plan Amendment were primarily derived from NRCS Fiscal Year 2013 Payment Schedule.

Grazing

Grazing activities occur throughout the North Coast Region both on private and public lands. As with the estimated costs to the irrigated agricultural community to comply with the draft Basin Plan Amendment, the estimates to the grazing community are derived from NRCS Fiscal Year 2013 Payment Schedule. Typical categories of compliance for grazing include maintaining and preserving site potential shade, controlling erosion and sediment delivery, preserving existing cold water resources, aquatic ecosystem restoration, and actions to restore or maintain stream flows to support all beneficial uses.

Dam Removal

The cost of removing dams varies with the height and width of the dam, but project-specific factors, such as structure type, stored sediments, water rights, easements, and the need for monitoring can greatly impact the total cost of treatment. Friends of the Earth , a Non-Governmental Organization, performed case studies of more than 30 dam removal projects in the United States and found that some small dams can be removed for under $10,000. The removal of a larger dam (e.g., 15-20 feet in height) can cost as much as $1 million. In neither case do these cost estimates include the important considerations of the cost of permits, easements, design, or monitoring. The median cost of dam removal in this study was about $100,000. However, this finding cannot be interpreted to suggest that this will always be true in California or elsewhere in the future. Previous dam removals were not the result of a random selection; it is likely that relatively inexpensive removal projects have been undertaken first and that average removal costs will rise over time. (Sunding, D./A. P. Zwane, 2004)

Table 6-3
Estimated Costs of Reasonably Foreseeable Compliance Measures to Preserve, Maintain and Restore Shade

Reasonably Foreseeable Compliance Measure	Practice Name	Range of Practice Costs	NRCS Practice Code or Source
Use Exclusion	Forage exclusion	$0.64-1.32/ft	#472
Riparian Restoration	Riparian forest buffer/herbaceous cover	$165.04-22,916.06/acre	#390, #391
Protect and manage existing wetland and/or riparian areas for their natural filtering functions	Riparian herbaceous cover/forest buffer, wetland restoration	$165.04-22,916.06/acre	#390, #391, #657
Animal Trails and Walkways	Animal trails and walkways	Not available	#575
Stream Crossing	Ford, culvert, bridge	$363-1,488 per/Lft	#578
Riparian Restoration	--	$44.03/ft^2 -$2,706/Lft	A.Riley, 2008
Riparian Restoration	--		A.Riley, 2008
Retain in-channel trees following timber operations Increased riparian canopy retention in Class II and III Watercourses	Not applicable	Dependent on site specific determinations	Staff judgment

Table 6-4
Estimated Costs of Reasonably Foreseeable Compliance Measures Associated with Erosion and Sediment Control

Reasonably Foreseeable Compliance Measure	Practice Name	Range of Practice Costs	NRCS Practice Code or Source
Reduce erosion - Maintain crop residue or vegetative cover	Cover Crop	$113.75-206.64/acre	#340
Erosion control	Dry Seed	$0.40/ft^2	Caltrans 2013
Erosion control	Compost Cover	$0.20-0.80/ft^2	Caltrans 2013
Erosion control	Compost Blanket	$250/cubic yard	Caltrans 2013
Erosion control	Rolled Erosion Control Blanket	$2.00/ft^2	Caltrans 2013
Erosion control	Straw	$0.05/ft^2	Caltrans 2013
Erosion control	Hydroseed	$0.05/ft^2	Caltrans 2013
Reduce erosion and sequester sediment - Stream buffer areas/Field borders	Field Borders: Riparian tree & shrub establishment; Non-native or native seedbed preparation	$211-1,617/acre	#386
Reduce erosion and sequester sediment - Riparian restoration	Tree & Shrub Establishment	$1.20-3.20/unit	#612
Reduce soil erosion - Improve soil properties	Deep tillage/1 Scenario	$20.10/acre	#324
	Res. & Tillage Mgt, Mulch Till	$28.10/acre	#345
Reduce slope length, steepness, or unsheltered distance	Precision land forming	$175/acre	#462
	Contour Farming	$10.10/acre	#330
	Contour Buffer Strips	$282.30-917.40/acres	#332
Reduce soil erosion - Practices to reduce detachment	Conservation Cover	$237.40-2,279.90/acre	#327
	Conservation Crop Rotation	$6.10-30.90 /acre	#328
	Residue and Till Management	$36-71.12/acre	#329
	Cover crop	$113.75-206.64/acre	#340
	Critical area planting	$398.21-14,046.80/acre	#342
	Seasonal residue management	$3.76/acre	#344
	Diversion	$3.17-5.69/ft	#362
	Windbreak/shelterbelt establishment	$0.45-0.90/ft	#380

Table 6-4
Estimated Costs of Reasonably Foreseeable Compliance Measures Associated with Erosion and Sediment Control

Reasonably Foreseeable Compliance Measure	Practice Name	Range of Practice Costs	NRCS Practice Code or Source
Practices to reduce detachment (cont.)	Windbreak/shelterbelt renovation	$0.56-4.77/ft	#650
	Mulching	$297.73-756.15/acre	#484
	Hydromulch	$0.05/yard^2	Caltrans 2013
	Irrigation water management	$28.09-202.12/acre	#449
	Cross wind ridges/stripcropping/trap strips	Not available	#589
	Surface roughening		
	Waste utilization	$175.21-949.51/acre	#612
	Wildlife upland habitat management	Not available	#633
		$17.50-392.05/acre	#645
Practices to reduce transport within the field	Contour farming	$304.10/acre	#330
	Field windbreak	Not available	#392
	Grassed waterway	$1502.42/acre	#412
	Contour stripcropping	$1.60-3.83/acre	#585
	Herbaceous wind barriers	Not available	#442A
	Field stripcropping	Not available	#586
	Terrace	$2.09-3.40/Lft	#600
	Contour buffer strips	$282.29-917.41/acre	#332
Practices to trap sediment below the field or critical area	Sediment basins	Not available	#350
	Field border	$210.57-1617.25/acre	#386
	Filter strip	$210.57-448.10/acre	#393
	Water and sediment control basin	$4.86/cubic yard	#638
Mulch exposed areas	Mulching	$297.73-756.15/acre	#484
Grazing Management Plan		To be determined	
Pasture and hay planting	Seedbed preparation, seeding, non-native	$191.43-501.24/acre	#512

Table 6-4
Estimated Costs of Reasonably Foreseeable Compliance Measures Associated with Erosion and Sediment Control

Reasonably Foreseeable Compliance Measure	Practice Name	Range of Practice Costs	NRCS Practice Code or Source
Rangeland planting	Drill or broadcast, native or non-native	Not available	#550
Animal trails and walkways	Animal trails and walkways	Not available	#575
Stream crossing	Ford, culvert, bridge	$90-1,488 per/Lft	#578/ Caltrans 2013
Forage harvest management	Forage harvest management	$12.74-61.61/acre	#511
Vegetation control with grazing	Prescribed grazing	$3.89-5.80/acre	#528
Wetland wildlife habitat management	Low, medium or high intensity	$17.50-248.94/acre	#644
Installation of grade stabilization structures	Grade stabilization structure	Not available	#410
Streambank and shoreline protection	Low-high complexity	$17.58-80.26/ft	#580
Stream channel stabilization	Stream channel stabilization	Not available	#584
Road Surface stabilization	Asphalt paving	$238,000/mile	Siskiyou County Public Works
	Asphalt paving	$115.00-300.00/ton	Caltrans 2013
	Chip sealing	$57,000/mile	Siskiyou County Public Works
	Rocking	$4,250-10,000/1000 ft	Weaver, et. al. (2006)
	Class II Aggregate Base	$75.00/cubic yard	Caltrans 2013
	Import Rock Material	$100.00/cubic yard	Caltrans 2013
	Dust abatement	$90hr	Harris Blade Rental,
Road Fill slope/cutbank compliance measures	Removal/stabilization of unstable fill.	$2-5/cubic yard	Weaver, et. al. (2006)
	Soil stabilization (mulch/vegetate) of fill and cut slopes.	$19-22/1,000 ft.	Weaver, et. al. (2006)
Control sediment	Disconnect road drainage from watercourses (drain to hillslopes).	$170/1,000 ft	Weaver, et. al. (2006)

Table 6-4
Estimated Costs of Reasonably Foreseeable Compliance Measures Associated with Erosion and Sediment Control

Reasonably Foreseeable Compliance Measure	Practice Name	Range of Practice Costs	NRCS Practice Code or Source
	Install rolling dip	$85-170/ each	Weaver, et. al. (2006)
	Install ditch relief culvert	$645-825/ each	Weaver, et. al. (2006)
	Install stream crossing	$3,270/each	Weaver, et. al. (2006)
	Fiber roll	$5.00-20.00/Lft	Caltrans 2013
	Silt fence	$8.00-20.00/Lft	Caltrans 2013
	Gavel check dam	$8.00-20.00/Lft	Caltrans 2013
Stabilize/treat crossing approach	Rock road surface	$4,250-10,000/1,000 ft	Weaver, et. al. (2006)
	Install additional road drainage: waterbars, rolling dips, cross drains	$85-3,270/each	Weaver, et. al. (2006)
Stabilize/treat crossings and associated fills	Remove undersized/failing culverts	$3-10/cubic yard	Weaver, et. al. (2006)
	Remove unstable fill	$2-5/cubic yard	Weaver, et. al. (2006)
	Rock armor, rip rap fill slopes	$150-725.00/Cubic yard	Caltrans 2013
	Rock slope protection fabric	$5.00-100.00/ $yard^2$	Caltrans
	Drain road away from unprotected fills	$10,000-75,000/mile	Weaver, et. al. (2006)
Develop a Road System Plan	Erosion Control Plan, non-timber land use	$3528-7,740/100 acres	R. Fitzgerald Memo dated August 6, 2005
	Erosion Control Plan, timber land use	$2,370-7,740/100 acre	
	Water Pollution Control Plan	$650-10,000/per	Caltrans 2013
Road decommissioning	Recontour road to provide for a stable, hydrologically "invisible" site (e.g. remove perched fill, outslope old road prism, remove crossings)	$2,000-$50,000/mile depending on steepness and location of road	Weaver, et. al. (2004)
	Minimize road system (density) to correspond with maintenance resources	$2,000-50,000/mile to recontour unnecessary roads	Weaver, et. al. (2004)
	Decommission roads adjacent to watercourse and relocate to midslope or ridgetop if possible	$3,000-23,000 per mile	CDFW Coho Recovery Plan

Table 6-5
Estimated Compliance Measures Costs to Address Tailwater/Surface Water Impoundments/ Cold Water Resources/In-Stream Flows

Reasonably Foreseeable Compliance Measure	NRCS Practice Name	NRCS Practice Cost	NRCS Practice Code
Irrigation scheduling	Irrigation water management	$28.09-202.12/acre	#449
Efficient application of irrigation water	Microirrigation	$503.85-1835.93/acre	#441
Efficient transport of irrigation water	Installation of piping to replace open ditches	$2.47-5.13/ft	#516
Use of runoff or tailwater	Irrigation system/tailwater recovery	Not available	#447
Management of drainage water	Runoff management system	Not available	#570
Vegetated filter strips	Filter strip	$210.57-448.10/acre	#393
Surface field ditch	Field ditch	Not available	#607
Water table control, controlled drainage	Subsurface drain	$3.86-6.44/ft	#606
Installation of pipeline for off-channel water	Pipeline, rough terrain, steel or plastic	$2.47-5.13/ft	#516
Constructing off-stream pond	Pond up to 50 AcFt	$12,969.38-32,068.24/no.	#378
Installing trough or tank for off-channel water	Watering facility	$1,958.69-5,020.64/no.	#614
Constructing well	Water well	$15,413.45-41,537.97/no.	#642
Improving springs	Spring development	$2,629.19-4,335.61/no.	#574
Barrier removal (dam)	NA	$10,00 -500,000/per	CDFW Coho Recovery Plan
Barrier removal (non-structural sites)	NA	$2,400-34,000/per	CDFW Coho Recovery Plan
Barrier removal (stream crossings)	NA	$15,000-500,000/per	CDFW Coho Recovery Plan
Riparian revegetation	NA	$5,000-135,000/acre	CDFW Coho Recovery Plan
Streambank restoration	NA	$125.00/ft^2	CDFW Coho Recovery Plan
Fencing	NA	$3.00-12.00/Lft	CDFW Coho Recovery Plan

6.4 Sources of Funding

Potential sources of funding include monies from private and public sources. Public financing includes, but is not limited to: grant funds, as described below; single-purpose appropriations from federal, state, and/or local legislative bodies; and bond indebtedness and loans from government institutions.

6.4.1 Summary of Pertinent State Funding Programs

There are several potential sources of public financing through grant and loan funding programs administered, at least in part, by the Regional Water Board and the State Water Board. The Division of Financial Assistance (DFA) administers the implementation of the State Water Board financial assistance programs that include loan and grant funding for construction of municipal sewage and water recycling facilities, remediation for underground storage tank releases, watershed protection projects, and nonpoint source pollution control projects.

The resources available through these programs vary over time depending upon federal and state budgets and ballot propositions approved by voters. State funding programs pertinent to the draft WQO Update Amendment are summarized and described below. Additional information can be found on the State Water Resources Control Board webpage. (http://www.waterboards.ca.gov/water_issues/programs/grants_loans/).

Clean Water State Revolving Fund

The Federal Water Pollution Control Act (Clean Water Act or CWA), as amended in 1987, provides for establishment of a Clean Water State Revolving Fund (CWSRF) program. The program is funded by federal grants, State funds, and Revenue Bonds. The purpose of the CWSRF program is to implement the CWA and various State laws by providing financial assistance for the construction of facilities or implementation of measures necessary to address water quality problems and to prevent pollution of the waters of the State, including federal waters.

The CWSRF Loan Program provides low-interest loan funding for construction of publicly-owned wastewater treatment facilities, local sewers, sewer interceptors, water recycling facilities, as well as, expanded use projects such as implementation of nonpoint source (NPS) projects or programs, development and implementation of estuary Comprehensive Conservation and Management Plans, and storm water treatment. Additional information can be found on the State Water Resources Control Board webpage http://www.waterboards.ca.gov/water_issues/programs/grants_loans/srf/

Safe Drinking Water State Revolving Fund

The Safe Drinking Water Act, as amended in 1996, established the Drinking Water State Revolving Fund (DWSRF) to make funds available to drinking water systems to finance infrastructure improvements. A noted priority of the program is to provide funds to small and disadvantaged communities and to programs that encourage pollution prevention as a

tool for ensuring safe drinking water. The fund provides low interest loans, grants, and other assistance to public water systems for the purpose of infrastructure improvements to correct system deficiencies and improve water quality. Detailed information on the program can be found in the annual Intended Use Plan.
http://www.cdph.ca.gov/services/funding/Pages/SRF.aspx

Proposition 50
Proposition 50, the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 (Water Code Section 79500, et seq.) was passed by California voters in the November 2002 general election. DDW is responsible for portions of the Act that deal with water security, safe drinking water, and treatment technology. DDW currently has funding available for projects designed to remove contaminants from drinking water supplies and/or install UV or ozone disinfection.

Proposition 84
Proposition 84, the Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Act of 2006 (Public Resources Code Section 75001, et seq.), was passed by California voters in the November 2006 general election. DDW is responsible for portions of the Act that deal with safe drinking water supplies, including emergency and urgent funding, infrastructure improvements, and groundwater quality. Integrated Regional Water Management program from DWR has funding available under Proposition 84 for projects that address critical drinking water supply or water quality needs for Disadvantaged Communities. Funding is also available for Urban Water Suppliers implementing leak detection and repair and installation of water meters Best Management Practices.

Integrated Regional Water Management Grants
Integrated Regional Water Management (IRWM) is a collaborative effort to manage all aspects of water resources in a region. IRWM crosses jurisdictional, watershed, and political boundaries; involves multiple agencies, stakeholders, individuals, and groups; and attempts to address the issues and differing perspectives of all the entities involved through mutually beneficial solutions. The Department of Water Resources has a number of IRWM grant program funding opportunities. Current IRWM grant programs include: planning, implementation, and storm water flood management. DWR's IRWM Grant Programs are managed within DWR's Division of IRWM by the Financial Assistance Branch with assistance from the Regional Planning Branch and regional offices.

Proposition 84 Storm Water Grant Program
The Public Resources Code (PRC) requires that the Proposition 84 Storm Water Grant Program (SWGP) funds be used to provide matching grants to local public agencies for the reduction and prevention of storm water contamination of rivers, lakes, and streams. The Legislature may enact legislation to further define this grant program.

AB 739 requires the development of project selection and evaluation guidelines for the Proposition 84 SWGP, and provides additional information regarding types of projects eligible for funding. AB 739 also requires creation of a Storm Water Advisory Task Force that will provide advice to the State Water Board on its Storm Water Management Program that may include program priorities, funding criteria, project selection, and interagency coordination of State programs that address storm water management.

State Water Resources Control Board Underground Storage Tank Cleanup Fund
The Underground Storage Tank (UST) Cleanup Fund (Fund) provides a means for petroleum UST owners and operators to meet the federal and state requirements of maintaining financial responsibility to pay for any damages arising from their tank operations. The Fund assists a large number of small businesses and individuals by providing reimbursement for expenses associated with the cleanup of leaking USTs. The Fund also provides money to the Regional Water Boards and local regulatory agencies to abate emergency situations or to clean up abandoned sites that pose a threat to human health, safety, and the environment, as a result of a UST petroleum release.

Clean Beach Initiative Grant Program
The CBI Grant Program provides funding for projects that restore and protect the water quality and the environment of coastal waters, estuaries, bays, and near shore waters. The CBI Grant Program was initiated in response to the poor water quality and significant exceedances of bacterial indicators revealed by Assembly Bill (AB) 411 (Stats. 1997, Ch. 765) monitoring at California's beaches. Scientific studies have shown that water with high bacteria levels can cause infections rashes, and gastrointestinal and respiratory illnesses.

The CBI Grant Program has provided about $100 million from voter-approved bonds for approximately 100 projects since it was started under the 2001 Budget Act. Typical projects include the construction of disinfecting facilities, diversions that prevent polluted storm water from reaching the beach, and scientific research that will enable early notification of unhealthy swimming conditions.

Agricultural Drainage Program
The Agricultural Drainage Loan Program was created by the Water Conservation and Water Quality Bond Act of 1986 to address treatment, storage, conveyance, or disposal of agricultural drainage water that threatens waters of the State. Loan repayments are for a period of up to 20 years. Eligible applicants include any city, county, district, joint powers authority or other political subdivision of the State involved with water management. Projects must address treatment, storage, conveyance or disposal of agricultural drainage that threaten waters of the State.

6.4.2 Summary of Pertinent Federal Funding Programs

Several federal agencies, including but not limited to the U.S. Environmental Protection Agency, NOAA Fisheries, U.S. Fish and Wildlife Service, and USDA Natural Resources

Conservation Service also provide grants and other funding opportunities. Table 6-6 presented below provides a summary of the pertinent federal funding programs.
The U.S. Environmental Protection Agency provides access through its webpage to a catalog of federal funding opportunities:
http://water.epa.gov/grants_funding/shedfund/databases.cfm

The U.S. Department of Agriculture – Natural Resource Conservation Service has a wide variety of agricultural/timber financial support programs. The Environmental Quality Incentives Program (EQIP) is a voluntary program that provides financial and technical assistance to agricultural producers through contracts up to a maximum term of ten years in length. These contracts provide financial assistance to help plan and implement conservation practices that address natural resource concerns and for opportunities to improve soil, water, plant, animal, air and related resources on agricultural land and non-industrial private forestland. In addition, one purpose of EQIP is to help producers meet Federal, State, Tribal and local environmental regulations. The financial assistance programs include:

- Agricultural Management Assistance
- Agricultural Water Enhancement Program
- Air Quality Initiative
- Cooperative Conservation Partnership Initiative
- Conservation Innovation Grants
- Conservation Stewardship Program
- Environmental Quality Incentives Program
- Emergency Watershed Protection Program
- Wildlife Habitat Incentive Program
- For additional agriculture specific grants:
  http://www.grants.gov/search-grants.html?fundingCategories%3DAG%7CAgriculture
  http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/cig/

Table 6-6
Summary of Federal Funding Programs

Funding Program	Programs Description	2014 Funding
Agency : National Fish and Wildlife Foundation (A non-profit organization created by Congress in 1984 to implement conservation grant funding through public/private partnerships under the leadership of the Secretary of the Interior)		
Environmental Solutions for Communities	In 2012, Wells Fargo and the National Fish and Wildlife Foundation launched the Environmental Solutions for Communities initiative, designed to support projects that link economic development and community well-being to the stewardship and health of the environment. This 5-year initiative is supported through a $15 million contribution from Wells Fargo that will be used to leverage other public and private investments with an expected total impact of over $37.5 million. Funding priorities for this program include: (1) supporting sustainable agricultural practices and private lands stewardship; (2) conserving critical land and water resources and	$3 million (est.)

Table 6-6
Summary of Federal Funding Programs

Funding Program	Programs Description	2014 Funding
	improving local water quality; (3) restoring and managing natural habitat, species and ecosystems that are important to community livelihoods; (4) facilitating investments in green infrastructure, renewable energy and energy efficiency; and (5) encouraging broad-based citizen participation in project implementation.	
Pulling Together Initiative	The National Fish and Wildlife Foundation's Pulling Together Initiative (PTI) provides a means for federal agencies to partner with state and local agencies, private landowners, and other interested parties to develop long-term weed management projects within the scope of an integrated pest management strategy. The goals of PTI are: (1) to prevent, manage, or eradicate invasive and noxious plants through a coordinated program of public/private partnerships; and (2) to increase public awareness of the adverse impacts of invasive and noxious plants. PTI provides support on a competitive basis for the formation of local weed management area (WMA) partnerships, allowing them to demonstrate successful collaborative efforts and develop permanent funding sources for the maintenance of WMAs from the involved parties. Successful projects will serve to increase public awareness and interest in future partnership projects.	TBD
Agency : National Oceanic and Atmospheric Administration		
Coastal Services Center Cooperative Agreements	The National Oceanic and Atmospheric Administration (NOAA) guides the conservation and management of coastal resources through a variety of mechanisms, including collaboration with the coastal resource management programs of the nation's states and territories. The mission of the NOAA Coastal Services Center (CSC) is to support the environmental, social, and economic well-being of the coast by linking people, information, and technology. The vision of the NOAA Coastal Services Center is to be the most useful government organization to those who manage and care for our nation's coasts.	$3.21million
Agency : U.S. Department of Agriculture		
Conservation Reserve Program	The Conservation Reserve Program (CRP) is a voluntary program for agricultural landowners. Through CRP, you can receive annual rental payments and cost-share assistance to establish long-term, resource conserving covers on eligible farmland.	$1.965 billion
Farm and Ranch Lands Protection Program (FRPP)	The USDA Natural Resources Conservation Service's Farmland Protection Program (FPP) is a voluntary program that helps farmers and ranchers to keep their land in agriculture and prevents conversion of agricultural land to non-agricultural uses. The program provides matching funds to agencies and organizations with existing farmland protection programs that enable them to purchase conservation easements. These cooperating entities purchase easements from landowners in exchange for a lump sum payment. The Federal contribution cannot to exceed 50 percent of the appraised fair market value of the land's development rights. The easements are for perpetuity unless prohibited by state law. Eligible land is land on a farm or ranch that has prime, unique, statewide, or locally important soil, that contains historical or archaeological resources; or that	$142.5 million (for technical and financial assistance) (est.)

Table 6-6
Summary of Federal Funding Programs

Funding Program	Programs Description	2014 Funding
	supports the policy of a State or local farm and ranch land protection policy; is subject to a pending offer by an eligible entity; and includes cropland, rangeland, grassland, pasture land, forest land and other incidental land that is part of an agricultural operation.	
Agricultural Management Assistance	Agricultural Management Assistance (AMA) provides cost share assistance to agricultural producers to voluntarily address issues such as water management, water quality, and erosion control by incorporating conservation into their farming operations. Producers may construct or improve water management structures or irrigation structures; plant trees for windbreaks or to improve water quality; and mitigate risk through production diversification or resource conservation practices, including soil erosion control, integrated pest management, or transition to organic farming.	$2.5 million
USDA's Small Business Innovation Research	To stimulate technological innovation in the private sector, strengthen the role of small businesses in meeting Federal research and development needs, increase private sector commercialization of innovations derived from USDA-supported research and development efforts, and foster and encourage participation, by women-owned and socially disadvantaged small business firms in technological innovation. The selected areas for research are Forests and Related Resources; Plant Production and Protection-Biology; Plant Production and Protection - Engineering; Animal Production and Protection; Air, Water and Soils; Food Science and Nutrition; Rural and Community Development; Aquaculture; Biofuels and Biobased Products; and Small and Mid-size Farms.	$20.5 million (est.)
Sustainable Agriculture Research and Education	The Sustainable Agriculture Research and Education (SARE) program of the U.S. Department of Agriculture National Institute of Food and Agriculture (NIFA) works to advance farming systems that are productive, profitable, environmentally sound and good for communities through a regional grants program. SARE funds research and extension activities to reduce the use of chemical pesticides, fertilizers, and toxic materials in agricultural production; to improve management of on-farm resources to enhance productivity, profitability, and competitiveness; to promote crop, livestock, and enterprise diversification and to facilitate the research of agricultural production systems in areas that possess various soil, climatic, and physical characteristics; to study farms that are managed using farm practices that optimize on-farm resources and conservation practices; and to promote partnerships among farmers, nonprofit organizations, agribusiness, and public and private research and extension institutions. Click on program name and check the link in the Primary Internet box for more information about grant opportunities and program results.	$22.7 million
Wetlands Reserve Program	Through this voluntary program, the USDA Natural Resources Conservation Service (NRCS) provides landowners with financial incentives to restore and protect wetlands in exchange for retiring marginal agricultural land. To participate in the program landowners	$230.5 million (est.)

Table 6-6
Summary of Federal Funding Programs

Funding Program	Programs Description	2014 Funding
	may sell a conservation easement or enter into a cost-share restoration agreement (landowners voluntarily limit future use of the land, but retain private ownership). Landowners and the NRCS jointly develop a plan for the restoration and maintenance of the wetland.	
Environmental Quality Incentives Program	The USDA Natural Resources Conservation Service's Environmental Quality Incentives Program (EQIP) was established to provide a voluntary conservation program for agricultural producers to address significant natural resource needs and objectives. Through a competitive process, EQIP offers financial assistance contracts with a maximum term of ten years, to help implement eligible conservation practices. Persons or legal entities, who are owners of land under agricultural production or who are engaged in livestock or agricultural production on eligible land, including private non-industrial forest land, or Indian Tribes may participate in EQIP. Conservation practices implemented through EQIP are subject to NRCS technical standards adapted for local conditions. NRCS or Technical Service Providers (TSPs) help applications develop a plan of operations which identifies practices needed to address natural resource concerns and support the EQIP contract.. EQIP-related programs include Conservation Innovation Grants (CIG), Resource Conservation Partnership Program (RCPP), and the National Water Quality Initiative (NWQI).	$981.7 million (Cost Share)
National Integrated Water Quality Program (NIWQP)	The National Integrated Water Quality Program (NIWQP) provides funding for research, education, and extension projects aimed at improving water quality in agricultural and rural watersheds. The NIWQP has identified eight "themes" that are being promoted in research, education and extension. The eight themes are (1) Animal manure and waste management (2) Drinking water and human health (3) Environmental restoration (4) Nutrient and pesticide management (5) Pollution assessment and prevention (6) Watershed management (7) Water conservation and agricultural water management (8) Water policy and economics. Awards are made in four program areas - National Projects, Regional Coordination Projects, Extension Education Projects, and Integrated Research, Education and Extension Projects. Please note that funding is only available to universities.	Not available
Agency : U.S. Department of Housing and Urban Development		
Community Development Block Grants/Entitlement Grants	The objective of this program is to develop viable urban communities, by providing decent housing and a suitable living environment, and by expanding economic opportunities, principally for persons of low and moderate income. Recipients may undertake a wide range of activities directed toward neighborhood revitalization, economic development and provision of improved community facilities and services.	$1.95 billion (est.)
Agency : U.S. Environmental Protection Agency		
Source Reduction Assistance Grant Program	The Source Reduction Assistance Grant Program provides grants and cooperative agreements to fund pollution prevention (source reduction and resource conservation) activities. Specifically, the Agency is interested in funding projects that help reduce hazardous substances, pollutants, or contaminants entering waste streams or otherwise	$1.0 million (est.)

Table 6-6
Summary of Federal Funding Programs

Funding Program	Programs Description	2014 Funding
	released into the environment (including fugitive emissions) prior to recycling, treatment, disposal or energy recovery activities.	
Clean Water State Revolving Fund	The EPA's Clean Water State Revolving Fund (CWSRF) program provides a permanent source of low-cost financing for a wide range of water quality infrastructure projects. These projects include traditional wastewater treatment and collection, nonpoint source pollution controls, and estuary management. Funds to capitalize the program are provided annually through federal grants and state matching funds (equal to 20 percent of federal grants). Monies are loaned to assistance recipients at below-market rates. In addition, states also have the ability to customize loan terms to benefit small and disadvantaged communities. Loan repayments are recycled back into the programs to fund additional projects. Since its inception, the CWSRF has provided over $95.4 billion in assistance to eligible borrowers, including communities of all sizes, farmers, small businesses, and nonprofit organizations. More information on the CWSRF program can be obtained at http://www.epa.gov/owm/cwfinance/cwsrf/	$1.1 billion (est.)
Nonpoint Source Implementation Grants (319 Program)	Through its 319 program, EPA provides formula grants to the states, territories and tribes to implement nonpoint source programs and projects and programs in accordance with section 319 of the Clean Water Act (CWA). Nonpoint source pollution projects can be used for a wide range of activities including agriculture, forestry, construction, and urban challenges. When set as priorities within a state's Nonpoint source management program, projects may also be used to protect source water areas and high quality waters. Examples of previously funded projects include installation of best management practices (BMPs) for animal waste; design and implementation of BMP systems for stream, lake, and estuary watersheds; and basin-wide landowner education programs. Most states provide opportunities for 3rd parties to apply for funds under a state request for proposal.	$159.3 million
Urban Waters Small Grants	EPA's Urban Waters Program protects and restores America's urban waterways. EPA's funding priority is to achieve the goals and commitments established in the Agency's Urban Waters Strategic Framework (www2.epa.gov/urbanwaters/urban-waters-strategic-framework). This program has an emphasis on engaging communities with environmental justice concerns. The objective of the Urban Waters Small Grants is to fund projects that will foster a comprehensive understanding of local urban water issues, identify and address these issues at the local level, and educate and empower the community. In particular, the Urban Waters Small Grants seek to help restore and protect urban water quality and revitalize adjacent neighborhoods by engaging communities in activities that increase their connection to, understanding of, and stewardship of local urban waterways.	$2.08 (est.)
Pollution Prevention Grant Program	The Pollution Prevention Grant Program provides grants and cooperative agreements to state agencies, instrumentalities of a state and federally recognized tribes to implement pollution prevention	$4.1 million (est.)

Table 6-6
Summary of Federal Funding Programs

Funding Program	Programs Description	2014 Funding
	projects that provide technical assistance to businesses. The program requires applicants to work towards reducing pollution, conserving energy and water, and saving dollars through P2 efforts; as indentified in EPA's Strategic Plan under Goal 4: Ensuring Safety of Chemicals and Preventing Pollution, Objective 4.2: Promote Pollution Prevention.	
Science to Achieve Results	The Science to Achieve Results (STAR) program is designed to improve the quality of science used in EPA's decision-making process. STAR funds are provided for research in the following the following priority areas: (1) Air, Climate and Energy: Anthropogenic Influences on Organic Aerosol Formation and Regional Climate Implications; Measurements and Modeling for Quantifying Air Quality and Climatic Impacts of Residential Biomass or Coal Combustion for Cooking, Heating, and Lighting. (2) Chemical Safety and Sustainability: Center for Sustainable Molecular Design; Center for Material Life Cycle Safety; Human Exposure to Chemicals in Consumer Products and Indoor Environments; Development and Use of Adverse Outcome Pathways that Predict Adverse Developmental Neurotoxicity. (3) Safe and Sustainable Water Resources: Sustainable Chesapeake: A Community-Based Approach to Stormwater Management Using Green Infrastructure; Performance and Effectiveness of Green Infrastructure Stormwater Management Approaches in the Urban Context: A Philadelphia Case Study; High Priority Water Quality and Availability Research. (4) Safe and Healthy Communities: Research with Children's Health; Children's Environmental Health and Disease Prevention Research Centers (with NIEHS); Science for Sustainable and Healthy Tribes; Healthy and Sustainable Schools: Environmental Factors, Children's Health and Performance, and Sustainable Building Practices. In addition to the solicitations identified above, other solicitations may be announced in the coming year. Please check the NCER website for an updated listing of all solicitations.	$61.1 million (est.)
Five-Star Restoration Program	The EPA supports the Five-Star Restoration Program by providing funds to the National Fish and Wildlife Foundation and its partners, the National Association of Counties, NOAA's Community-based Restoration Program and the Wildlife Habitat Council. These groups then make subgrants to support community-based wetland and riparian restoration projects. Competitive projects will have a strong on-the-ground habitat restoration component that provides long-term ecological, educational, and/or socioeconomic benefits to the people and their community. Preference will be given to projects that are part of a larger watershed or community stewardship effort and include a description of long-term management activities. Projects must involve contributions from multiple and diverse partners, including citizen volunteer organizations, corporations, private landowners, local conservation organizations, youth groups, charitable foundations, and other federal, state, and tribal agencies and local governments. Each project would ideally involve at least five partners who are expected to contribute funding, land, technical assistance, workforce support, or other in-kind services that are equivalent to the federal contribution.	TBD

Table 6-6
Summary of Federal Funding Programs

Funding Program	Programs Description	2014 Funding
Regional Agricultural IPM Grants	The objective is to support Integrated Pest Management (IPM) implementation and approaches that reduce the risks associated with agricultural pesticide use in the United States. Regional Agricultural IPM Grants will support the implementation of IPM approaches to reduce pesticide risk in agricultural settings in the United States. Projects must address the national pesticide program stewardship priorities related to pest management needs and IPM program implementation stated in the announcement.	TBD
Agency : U.S. Fish and Wildlife Service		
Partners for Fish and Wildlife Program	The Partners for Fish and Wildlife Program provides technical and financial assistance to private landowners to restore fish and wildlife habitats on their lands via cooperative agreements. Since 1987, the program has partnered with more than 37,700 landowners to restore 765,400 acres of wetlands; over 1.9 million acres of grasslands and other upland habitats; and 6,560 miles of in-stream and streamside habitat. In addition, the program restores stream habitat for fish and other aquatic species by removing barriers to passage.	$20 million
Cooperative Endangered Species Conservation Fund	The U.S. Fish and Wildlife Service's (USFWS) Cooperative Endangered Species Conservation Fund provides financial assistance to states and territories that have entered into cooperative agreements with the USFWS to assist in the development of programs for the conservation of endangered and threatened species. The assistance provided to the state or territorial wildlife agency can include animal, plant, and habitat surveys; research; planning; monitoring; habitat protection, restoration, management, and acquisition; and public education. The Fund is dispersed to the states and territories through four programs: Conservation Grants, Habitat Conservation Planning Assistance Grants, Habitat Conservation Plan Land Acquisition Grants, and Recovery Land Acquisition Grants. Although not directly eligible for these grants, third parties such as nonprofit organizations and local governments may work with their state or territorial wildlife agency to apply for these funds.	$62 million (est.)
North American Wetlands Conservation Act Grants Program	The U.S. Fish and Wildlife Service's Division of Bird Habitat Conservation administers this matching grants program to carry out wetlands and associated uplands conservation projects in the United States, Canada, and Mexico. Grant requests must be matched by a partnership with nonfederal funds at a minimum 1:1 ratio. Conservation activities supported by the Act in the United States and Canada include habitat protection, restoration, and enhancement. Mexican partnerships may also develop training, educational, and management programs and conduct sustainable-use studies. Project proposals must meet certain biological criteria established under the Act. Visit the program web site for more information. (Click on the hyperlinked program name to see the listing for "Primary Internet".)	$70 million (est.)

https://ofmpub.epa.gov/apex/watershedfunding/f?p=109:1:0::NO:RP::#search_results

7. Antidegradation

This chapter of the staff report provides the regulatory analyses required to determine if the draft WQO Update Amendment is consistent with federal and state antidegradation policies.

Both USEPA and the State Water Board have adopted antidegradation policies as part of an approach to develop water quality standards and regulate the discharge of waste.

Clean Water Act (CWA) Section 303(c) requires that states adopt and modify, as appropriate, water quality standards for surface waters that protect public health and welfare, enhance the quality of water, and serve the purposes of the CWA. A water quality standard defines the water quality goals of a waterbody by:

- Designating the use or uses to be made of the water (beneficial uses);
- Setting numeric and/or narrative water quality objectives necessary to protect those uses; and
- Preventing degradation of water quality through antidegradation provisions.[1]

Water quality objectives must be based on sound scientific rationale and protect the beneficial uses of the receiving water.[2] Regional water boards must adopt water quality objectives that reasonably protect beneficial uses and prevent nuisance.[3]

The federal antidegradation policy requires that existing instream designated uses and the level of water quality necessary to protect the existing uses be maintained and protected.[4] As defined in the federal policy,[5] existing uses are those uses actually attained in the waterbody on or after November 28, 1975, whether or not they are included in the water quality standards. Where, however, the quality of the water exceeds levels necessary to support propagation of fish, shellfish, and wildlife, and recreation in and out of the water, that quality must be maintained and protected unless the state finds that:

1. Such activity is necessary to accommodate important economic or social development in the area in which the waters are located;
2. Water quality is adequate to protect existing beneficial uses fully; and
3. The highest statutory and regulatory requirements for all new and existing point source discharges and all cost-effective and reasonable best management practices for nonpoint source control are achieved.[6]

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1 U.S. EPA, Guidance re: Antidegradation; regulatory interpretation of 40 C.F.R. § 131.12(a)(2), March 1994.
2 40 C.F.R. § 131.11.
3 Wat. Code § 13241.
4 40 C.F.R. § 131.12.
5 40 C.F.R. § 131.3(e).
6 40 C.F.R. § 131.12.

The federal policy also requires that the state water quality standards include an antidegradation policy consistent with the federal policy. The State Water Board established California's antidegradation policy in 1968 with adoption of the *Statement of Policy for Respect to Maintaining High Quality of Waters in California* (state Antidegradation Policy).[7] The state Antidegradation Policy is considered to incorporate the federal Antidegradation Policy where the federal policy applies.[8]

The state Antidegradation Policy expresses the State Water Board's intent that the quality of existing high quality waters be maintained to the maximum extent possible. The state antidegradation Policy, unlike the federal policy, applies to both groundwater and surface waters whose quality meets or exceeds (are better than) water quality objectives.

The state Antidegradation Policy requires that existing quality of waters be maintained unless degradation is justified based on specific findings. The state Antidegradation Policy allows for the lowering of water quality only if the change:

- Is consistent with the maximum benefit to the people of the state;
- Will not unreasonably affect present and anticipated beneficial uses of waters; and
- Will not result in water quality less than that prescribed in applicable policies.

In addition, before any degradation of water quality is permitted, it must be shown that the discharge will be required to meet waste discharge requirements that result in best practicable treatment or control of the discharge necessary to assure that:

- Pollution or nuisance will not occur;
- The highest water quality consistent with maximum benefit to the people of the state is maintained.

Issues of antidegradation are considered by the Regional Water Board when issuing, reissuing, amending, or revising permits and orders if there is the potential for water quality degradation from the discharge. Antidegradation analyses are routinely prepared as part of the Regional Water Board's permit and order adoption process.

The draft WQO Update Amendment itself does not directly authorize any discharges to either surface waters or groundwaters. The four principal elements of the WQO Update Amendment are: 1) the addition of a groundwater toxicity objective; 2) the revision of the chemical constituents objective to delete outdated chemical specific numeric objectives; 3) the revision of the dissolved oxygen (DO) objective for surface waters; and 4) the addition of clarifying language on the implementation of water quality objectives. The groundwater

[7] State Water Board Resolution No. 68-16.
[8] State Water Board Order WQO 86-17.

toxicity objective is a narrative objective, which is subject to applicable statewide and regional policies when narrative objectives are translated into numeric forms for the purpose of permits, orders, and other regulatory actions.

The amendment of the water quality objectives proposed as part of this recommended action is important within the context of the Antidegradation Policy inasmuch as the water quality objectives are the basis for defining high quality waters (e.g., ambient waters better than water quality objectives). This is specifically true with respect to the proposed revisions to the chemical constituents objective and the DO objectives.

The proposed revisions to the DO objectives include an update to the daily minimum DO objectives to address acute DO stress, as well as the addition of average DO objectives designed to protect against chronic DO stress conditions for aquatic organisms. They also establish as the ambient water quality objective, natural background DO conditions in those waters judged to exceed aquatic life-based objectives due to natural conditions. In both cases, the definition of high quality waters has been explicitly tied to either the protection of the most sensitive aquatic receptors, or natural background, as appropriate. Ambient water quality that is better than that which is needed to protect the most sensitive aquatic receptors is appropriately defined as high quality, as are natural background conditions.

The proposed revision to the chemical constituents objective includes two parts. One is to expand the narrative objective to protect all beneficial uses from the adverse effects of chemical constituents. The other is to replace the existing chemical-specific numeric objectives (i.e. Table 3-2) with the prospective incorporation of Title 22 primary and secondary MCLs. As described in more detail below, there are 7 constituents for which the MCL is higher than the existing numeric water quality objective, offering the potential for a reduction in the number of those waters which would be defined as high quality, with respect to the noted 7 constituents. As shown in Table 7-1, the constituents in question are: 2,4,5-TP (Silvex), endrin, ethylene dibromide, lead, monochlorobenzene, selenium, and silver. This potential, however, is offset by the expansion of the narrative objective to apply to the protection of all beneficial uses. This is because, when the narrative objective is translated into numeric threshold values in permits, orders, or other regulatory actions, the MCL is treated as the ceiling, whereas much lower numeric values otherwise generally apply.

It can be difficult to compare the existing values in Table 3-2 with the values that will be based on the narrative process, since the application of appropriate numeric values is waterbody-specific. For example a publically owned treatment works (POTW), cleanup site and discharge of waste to land (i.e, winery process water) would each have different discharges, site characteristics, and relevant policies. The variability in the region adds to the complexity. A comparison of Table 3-2 and the current Maximum Contaminant Levels (MCLs) in Title 22 is presented in Table 7-1. This comparison indicates the need to look more closely at a few constituents to ensure that backsliding would not occur based on the current levels present in Table 3-2. Sections 402(o)(2) and 303(d)(4) of the CWA and federal regulations at 40 C.F.R. section 122.44(l) restrict backsliding in NPDES permits. These anti-backsliding provisions require that effluent limitations in a reissued permit must be as stringent as those in the previous permit, with some exceptions in which limitations may be relaxed. Staff analyzed information regarding these constituents to in order to determine if backsliding under the antidegradation policies could be a potential issue.

The MCL values for endrin and monochlorobenzene presented in Table 3-2 are lower than those more recently established under Title 22 to protect drinking water supplies at 2.0 micrograms per liter (µg/L) and 70 µg/L, respectively. In comparison the current Basin Plan values for endrin and monochlorobenzene are 0.2 µg/L and 30 µg/L, respectively. However, based on a review of the Water Quality Goals online database, it is apparent that when determining a numeric limit that would be protective of the most sensitive use, a number would be chosen that would be more protective than the current MCLs to meet antidegradation requirements. For example the USEPA National Recommended Water Quality Criteria for Human Health & Welfare Protection values for endrin and monochlorobenzene are 0.06 µg/L and 20 µg/L, respectively. These values are appropriate to use in regulatory actions as they are intended to protect drinking water for human consumption and would be used in the context of protecting the municipal and domestic water supply (MUN) beneficial uses.

Silver currently has an MCL of 100 µg/L, while an earlier MCL included in Table 3-2 is 50µg/L. However, by implementing the narrative toxicity objective staff can readily find the appropriate drinking water health advisories or suggested no-adverse-response levels for non-cancer health effects. For instance USEPA has developed an Integrated Risk Information System (IRIS) Reference dose (RfD) of 35µg/L for silver. Therefore, through the application of the narrative water quality objectives and Policy there will be no relaxation or backsliding.

Lead has been listed in Table 3-2 since the 1975 version of the Basin Plan. The MCL for lead listed in Table 3-2 is currently 50 µg/L. However, Title 22 does not currently contain an MCL for lead. Although, the USEPA Primary MCL for lead is 15 µg/L and even more applicable for the protection of the MUN beneficial use is the California Office of Environmental Health and Hazard Assessment (OEHHA) Public Health Goal (PHG) of 0.2 µg/L. Therefore, through the application of the narrative water quality objective there will be no relaxation or backsliding.

Fluoride MCLs currently listed in Table 3-2 are dependent on the average annual maximum daily air temperature ranging from 600 µg/L to 2,400 µg/L. Title 22 no longer specifies temperature dependent MCLs for fluoride. Rather, a single MCL value of 2,000 µg/L has been set for fluoride and is contained in the Title 22 section pertaining to inorganic chemical MCLs. However, the OEHHA PHG is set at 1,000 µg/L, while the USEPA IRIS RfD is set at 420 µg/L. Therefore, through the application of the narrative water quality objectives there will be no relaxation or backsliding.

2,4,5-TP (Silvex) currently has an MCL of 50 µg/L, while an earlier MCL included in Table 3-2 is 10 µg/L. However, the USEPA national recommended water quality criterion for water consumption is 10 µg/L and the OEHHA PHG is 3.0 µg/L. Therefore, through the application of the narrative water quality objective there will be no relaxation or backsliding.

Ethylene Dibromide currently has an MCL of 0.05 µg/L, while an earlier MCL included in Table 3-2 is 0.02 µg/L. However, the USEPA IRIS RfD of 0.02µg/L and the OEHHA PHG is 0.01 µg/L. Therefore, through the application of the narrative water quality objective there will be no relaxation or backsliding.

While there is complexity in the existing regulation it can be reduced to two simple concepts: 1) the application of narrative and numeric water quality objective to protect beneficial uses; and 2) the maintenance of high quality waters. The draft WQO Update Amendment not only adds explicit language to the revised water quality objectives it adds additional language to clarify the application of water quality objectives and the Antidegrdation Policies. The existing regulatory process, as described in this Staff Report, will result in staff recommending a value that is protective of the most sensitive beneficial use of water (e.g., municipal and domestic supply, aquatic-resource related beneficial uses), in a manner identical to the historical process it has undertaken in the absence of such explicit basin plan language. This approach will ensure that there is a process in place to appropriately determine waterbody-specific water quality limits to protect against degradation that would unreasonably affect the most sensitive beneficial use.

Table 7-1 Existing Basin Plan Objectives for Chemical Constituents Vs. Current Title 22 Maximum Contaminant Levels				
Constituent	**Basin Plan Table 3-2 (or Radioactivity Objective)**	**Current Title 22 MCL**	**Units**	**Most Stringent**
1,1,1-Trichloroethane	0.200	0.200	mg/L	Same
1,1,2,2-Tetrachloroethane	0.001	0.001	mg/L	Same
1,1,2-Trichloro-1,2,2-Trifluoroethane	1.2	1.2	mg/L	Same
1,1,2-Trichloroethane	0.032	0.005	mg/L	Title 22
1,1-Dichloroethane	0.005	0.005	mg/L	Same
1,1-Dichloroethylene	0.006	0.006	mg/L	Same
1,2,4-Trichlorobenzene	N/A	0.005	mg/L	Title 22
1,2-Dichlorobenzene	N/A	0.6	mg/L	Title 22
1,2-Dichloroethane	0.0005	0.0005	mg/L	Same
1,2-Dichloropropane	0.005	0.005	mg/L	Same
1,3-Dichloropropene	0.0005	0.0005	mg/L	Same
1,4-Dichlorobenzene	0.005	0.005	mg/L	Same
2,3,7,8-TCDD (Dioxin)	N/A	3E-08	mg/L	Title 22
2,4,5-TP (Silvex)	0.01	0.05	mg/L	Table 3-2
2,4-D	0.1	0.07	mg/L	Title 22
Alachlor	N/A	0.002	mg/L	Title 22
Aluminum	Only as MCL	0.2	mg/L	Title 22
Aluminum	1.0	1.0	mg/L	Same
Antimony	N/A	0.006	mg/L	Title 22
Arsenic	0.05	0.010	mg/L	Title 22
Asbestos	N/A	7000	MFL	Title 22
Atrazine	0.003	0.001	mg/L	Title 22
Barium	1.0	1.0	mg/L	Same
Bentazon	0.018	0.018	mg/L	Same
Benzene	0.001	0.001	mg/L	Same
Benzo(a)Pyrene	N/A	0.0002	mg/L	Title 22
Beryllium	N/A	0.004	mg/L	Title 22
Cadmium	0.01	0.005	mg/L	Title 22
Carbofuran	0.018	0.018	mg/L	Same
Carbon Tetrachloride	0.0005	0.0005	mg/L	Same
Chlordane	0.0001	0.0001	mg/L	Same
Chloride	N/A	250	mg/L	Title 22
Chromium	0.05	0.05	mg/L	Same
cis-1,2-Dichloroethylene	0.006	0.006	mg/L	Same
Color	N/A	15	Units	Title 22

Table 7-1 Existing Basin Plan Objectives for Chemical Constituents Vs. Current Title 22 Maximum Contaminant Levels				
Constituent	**Basin Plan Table 3-2 (or Radioactivity Objective)**	**Current Title 22 MCL**	**Units**	**Most Stringent**
Combined Radium-226 and Radium-228	5	5	pCi/L	Same
Copper	N/A	1	mg/L	Title 22
Cyanide	N/A	0.15	mg/L	Title 22
Dalapon	N/A	0.2	mg/L	Title 22
Di(2-ethylhexyl)adipate	N/A	0.4	mg/L	Title 22
Di(2-ethylhexyl)phthalate	0.004	0.004	mg/L	Same
Dibromochloropropane (a.k.a. 1,2-Dibromo-3-chloropropane)	0.0002	0.0002	mg/L	Same
Dichloromethane	N/A	0.005	mg/L	Title 22
Dinoseb	N/A	0.007	mg/L	Title 22
Diquat	N/A	0.02	mg/L	Title 22
Endothall	N/A	0.1	mg/L	Title 22
Endrin	0.0002	0.002	mg/L	Table 3-2
Ethylbenzene	0.680	0.3	mg/L	Title 22
Ethylene Dibromide	0.00002	0.00005	mg/L	Table 3-2
Fluoride	0.6 to 2.4	2.0	mg/L	
Foaming Agents (MBAS)	N/A	0.5	mg/L	Title 22
Glyphosate	0.7	0.7	mg/L	Same
Gross Alpha particle activity (including Radium-226 but excluding Radon and Uranium)	15	15	pCi/L	Same
Gross Beta particle activity	50	50	pCi/L	Same
Heptachlor	0.00001	0.00001	mg/L	Same
Heptachlor Epoxide	0.00001	0.00001	mg/L	Same
Hexachlorobenzene	N/A	0.001	mg/L	Title 22
Hexachlorocyclopentadiene	N/A	0.05	mg/L	Title 22
Iron	N/A	0.3	mg/L	Title 22
Lead	0.05	N/A	mg/L	Table 3-2
Lindane	0.004	0.0002	mg/L	Title 22
Manganese	N/A	0.05	mg/L	Title 22
Mercury	0.002	0.002	mg/L	Same
Methoxychlor	0.1	0.03	mg/L	Title 22
Methyl-tert-butyl ether (MTBE)	N/A	0.013	mg/L	Title 22
Methyl-tert-butyl ether (MTBE)	N/A	0.005	mg/L	Title 22
Molinate	0.02	0.02	mg/L	Same

Table 7-1 Existing Basin Plan Objectives for Chemical Constituents Vs. Current Title 22 Maximum Contaminant Levels				
Constituent	**Basin Plan Table 3-2 (or Radioactivity Objective)**	**Current Title 22 MCL**	**Units**	**Most Stringent**
Monochlorobenzene	0.030	0.07	mg/L	Table 3-2
Nickel	N/A	0.1	mg/L	Title 22
Nitrate+Nitrite (sum as nitrogen)	N/A	10.0	mg/L	Title 22
Nitrate-N (as NO_3)	45.0	45.0	mg/L	Same
Nitrite (as nitrogen)	N/A	1.0	mg/L	Title 22
Odor-Threshold	N/A	3	Units	Title 22
Oxamyl	N/A	0.05	mg/L	Title 22
Pentachlorophenol	N/A	0.001	mg/L	Title 22
Perchlorate	N/A	0.006	mg/L	Title 22
Picloram	N/A	0.5	mg/L	Title 22
Polychlorinated Biphenyls	N/A	0.0005	mg/L	Title 22
Selenium	0.01	0.05	mg/L	Table 3-2
Silver	0.05	0.1	mg/L	Table 3-2
Simazine	0.010	0.004	mg/L	Title 22
Specific Conductance	N/A	900	µS/cm	Title 22
Strontium-90	8	8	pCi/L	Same
Styrene	N/A	0.1	mg/L	Title 22
Sulfate	N/A	250	mg/L	Title 22
Tetrachloroethylene	0.005	0.005	mg/L	Same
Thallium	N/A	0.002	mg/L	Title 22
Thiobencarb	Only as MCL	0.001	mg/L	Title 22
Thiobencarb	0.07	0.07	mg/L	Same
Toluene	N/A	0.15	mg/L	Title 22
Total Dissolved Solids	N/A	500	mg/L	Title 22
Toxaphene	0.005	0.003	mg/L	Title 22
trans-1,2-Dichloroethylene	0.01	0.01	mg/L	Same
Trichloroethylene	0.005	0.005	mg/L	Same
Trichlorofluoromethane	0.15	0.15	mg/L	Same
Tritium	20000	20000	pCi/L	Same
Turbidity	N/A	5	Units	Title 22
Uranium	20	20	pCi/L	Same
Vinyl Chloride	0.0005	0.0005	mg/L	Same
Xylenes	1.750	1.750	mg/L	Same
Zinc	N/A	5	mg/L	Title 22

mg/L – milligrams per liter / N/A – not applicable / µS/cm – microSiemens per centimeter / pCi/L – picocures per liter

Shading indicates where numeric values were lower within Table 3-2 of the existing Basin Plan as compared to the values current MCLs

8 Public Participation Plan

This section of the staff report describes the efforts of the Regional Water Board to have successful, effective, and efficient public participation in the development of the draft WQO Update Amendment. The efforts identified in this chapter have been, carried out to identify interested stakeholders and to inform the public on development of the draft WQO Update Amendment. Regional Water Board staff worked to solicit early public comments on this proposal. Stakeholders have included landowners, residents, business owners, special interest groups, governmental officials and staff, non-governmental organizations, and other interested parties.

The primary goals of stakeholder outreach efforts are as follows:

- To communicate and inform stakeholders about the draft Basin Plan amendment, including the status of the development of the amendment, alternatives considered, implementation program options, potential environmental impacts, and other components of the Basin Plan amendment process.
- To solicit and receive relevant and timely input from stakeholders.

8.1 Stakeholder Involvement

Regional Water Board staff used a number of avenues to provide information and opportunities for continued public involvement in the draft WQO Update Amendment. Whenever requested, staff meets with interested stakeholders to provide updates and receive comments on the draft WQO Update Amendment. Regional Water Board staff meet with many of the stakeholder groups that are involved with water quality issues in the region in order to seek input and communicate the status of draft amendments, including the WQO Update Amendment. When feasible, staff attends regular meetings of established stakeholder groups, or staff organizes separate ad hoc meetings. In the case of the draft WQO Update Amendment, a number of cities and wastewater treatment consortiums have provided input. Staff has held individual meetings with these groups to discuss the changes to the draft amendment that have resulted from public input on the draft.

An informational webpage is maintained with contact information, status updates, links to available documents, public notices of meetings and comment periods, and other opportunities for stakeholder involvement. A full chronological list of the documents related to the draft Basin Plan amendment can be viewed and downloaded from the following location:
http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/water_quality_objectives_update_amendment.shtml

A CEQA scoping meeting introducing the goals of the draft WQO Update Amendment was held in Santa Rosa, California on July 8, 2010. The purpose of the meeting was to present the goals of the project and receive input from the public on the possible environmental impacts of the project. In August 2011, a notice was sent to interested stakeholders (subscribers of the Basin Plan amendment email list) announcing the posting of the public participation plan on the Regional Water Board's website. Separate CEQA Scoping meetings were held on the proposed DO objective amendment in October 2008, including meetings in Santa Rosa and Weaverville. Further, the Regional Water Board adopted Site Specific Objectives (SSO) for DO in the Klamath River mainstem in March 2010, based on the approach proposed in the draft DO objectives described in this report. The State Water Board, Office of Adminstrative Law, and U.S. Environmental Protection Agency approved the SSO in 2010. Staff conducted public workshops in Santa Rosa and Weaverville (November 3 and 8, 2011, respectively) to update the Regional Water Board and the public on the status of the draft WQO Update Amendment (absent the proposed DO objectives). An additional public workshop was held during the Regional Water Board's March 15, 2012 meeting.

Following an initial 45-day public comment period in February and March 2012, appropriate revisions to the staff report, including the draft WQO Update Amendment language and the environmental checklist and analyses (referred to as the substitute environmental documentation were made. A second public comment period for the revised documents was held in February and March of 2013. Again staff reviewed comments, held stakeholder meetings and provided an informational update to the Regional Water Board is June 2013. After lengthy consideration of public comments, Regional Water Board member comments and internal deliberation staff made significant revisions to the draft WQO Update Amendment and associated Staff Report. Now in its third iteration and public comment period staff plan to respond to all written comments received during the comment period. Regional Water Board staff plan to conduct a public workshop in March 2015 and present the draft WQO Update Amendment to the Regional Water Board for consideration of adoption in June 2015.

The Response to Comments document will be posted on the Regional Water Board website, and made available to the public and Board members prior to the adoption hearing. Notices of public meetings, document availability, public comment periods, and other opportunities for stakeholder involvement are sent via e-mail to interested parties that have provided their e-mail address or signed up via the web-based email list subscription form. Available at:
http://www.waterboards.ca.gov/resources/email_subscriptions/reg1_subscribe.shtml

Hard copies are provided if requested by interested parties. As required by law, public notice of the Regional Water Board hearing to consider adoption of the draft WQO Update Amendment will be printed in a newspaper of general circulation within the region.[1]

[1] 40 C.F.R. part 35.

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Soil, Sediment, Bedrock and Sludge Treatment Technologies

In Situ Biological Treatment

- 4.1 Bioventing
- 4.2 Enhanced Bioremediation
- 4.3 Phytoremediation

In Situ Physical/Chemical Treatment

- 4.4 Chemical Oxidation
- 4.5 Electrokinetic Separation
- 4.6 Fracturing
- 4.7 Soil Flushing
- 4.8 Soil Vapor Extraction
- 4.9 Solidification/Stabilization

In Situ Thermal Treatment

- 4.10 Thermal Treatment

Ex Situ Biological Treatment

- 4.11 Biopiles
- 4.12 Composting
- 4.13 Landfarming
- 4.14 Slurry Phase Biological Treatment

Ex Situ Physical/Chemical Treatment (Assuming Excavation)

- 4.15 Chemical Extraction
- 4.16 Chemical Reduction/Oxidation
- 4.17 Dehalogenation
- 4.18 Separation
- 4.19 Soil Washing
- 4.20 Solidification/Stabilization

Ex Situ Thermal Treatment (assuming excavation)

- 4.21 Hot Gas Decontamination
- 4.22 Incineration
- 4.23 Open Burn/Open Detonation
- 4.24 Pyrolysis
- 4.25 Thermal Desorption
- 4.26 Landfill Cap
- 4.27 Landfill Cap Enhancements/Alternatives

Other Treatment

- 4.28 Excavation, Retrieval, and Off-Site

Ground Water, Surface Water, and Leachate Treatment Technologies

In Situ Biological Treatment

- 4.29 Enhanced Bioremediation
- 4.30 Monitored Natural Attenuation
- 4.31 Phytoremediation

In Situ Physical/Chemical Treatment

- 4.32 Air Sparging
- 4.33 Bioslurping
- 4.34 Chemical Oxidation
- 4.35 Directional Wells
- 4.36 Dual Phase Extraction
- 4.37 Thermal Treatment
- 4.38 Hydrofracturing Enhancements
- 4.39 In-Well Air Stripping
- 4.40 Passive/Reactive Treatment Walls

Ex Situ Biological Treatment

- 4.41 Bioreactors
- 4.42 Constructed Wetlands

Ex Situ Physical/Chemical Treatment (assuming pumping)

- 4.43 Adsorption/Absorption
- 4.44 Advanced Oxidation Processes
- 4.45 Air Stripping
- 4.46 Granulated Activated Carbon (GAC)/Liquid Phase Carbon Adsorption
- 4.47 Ground Water Pumping/Pump and Treat
- 4.48 Ion Exchange
- 4.49 Precipitation/Coagulation/Flocculation
- 4.50 Separation
- 4.51 Sprinkler Irrigation

Containment

- 4.52 Physical Barriers
- 4.53 Deep Well Injection

Air Emissions/Off-Gas Treatment

- 4.54 Biofiltration
- 4.55 High Energy Destruction
- 4.56 Membrane Separation
- 4.57 Oxidation
- 4.58 Scrubbers
- 4.59 Vapor Phase Carbon Adsorption

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Biological Treatment (Secondary and Advanced)

- Fine Bubble Aeration

Decentralized Systems Technology

- Aerobic Treatment
- Control Panels
- Evapotranspiration
- Intermittent Sand Filters
- Low Pressure Pipe Systems
- Mound Systems
- Recirculating Sand Filters
- Septage Treatment/Disposal
- Septic Tank Effluent Screens
- Septic Tank-Soil Absorption Systems
- Septic Tank Systems for Large Flow Applications
- Septic System Tank
- Septic Tank Leaching Chamber
- Septic Tank Polishing
- Small Diameter Gravity Sewers
- Types of Filters

Disinfection

- Chlorine Disinfection
- Ozone Disinfection
- Ultraviolet Disinfection

Wastewater Technology Fact Sheets

- Aerated, Partial Mix Lagoons
- Anaerobic Lagoons
- Ammonia Stripping
- Ballasted Flocculation
- Chemical Precipitation
- Dechlorination
- Denitrifying Filters
- Disinfection for Small Systems
- External Carbon Sources for Nitrogen Removal
- Facultative Lagoons
- Free Water Surface Wetlands
- Granular Activated Carbon Absorption & Regeneration
- In-Plant Pump Stations
- Living Machine
- Membrane Bioreactors
- Oxidation Ditches
- Package Plants
- Pipe Construction and Materials
- Rapid Infiltration

- Rock Media Polishing Filter For Lagoons
- Screening and Grit Removal
- Sewers, Pressure
- Sewers, Force Main
- Side Stream Nutrient Removal
- Slow Rate Land treatment
- Trickling Filter Nitrification
- Trickling Filters
- Wetlands: Subsurface Flow
- Wetlands: Subsurface Flow

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Appendix A

This appendix contains the strikethrough/underline version of the proposed changes to Section 3 - Water Quality Objectives.

Notes to Readers:

1) *The following provides existing and new language for Chapter 3 – Water Quality Objectives. Revisions to the Chapter are shown in strikethrough and underline format. Proposed deletions to the original Basin Plan language are shown in ~~strikethrough~~. Proposed additions are indicated by underlining. Formatting changes, such as deletion of extra spaces, reformatting of paragraphs and tables, additions of bullets, etc., are not necessarily reflected in strikethough/underline format.*

2) This update proposes to rename sections of the Basin Plan to chapters.

3. WATER QUALITY OBJECTIVES

3.1 INTRODUCTION

The California Water Code, Division 7, Chapter 4, Section 13241 specifies that eachThe Regional Water Quality Control Board (Regional Water Board) shall is responsible for establishing water quality objectives (objectives) which, in the Regional Water Board's judgment, are necessary for the reasonable protection of the beneficial uses of water (beneficial uses) and for the prevention of nuisance.[1] The beneficial uses of waters in the North Coast Region are described in Chapter 2 and include uses associated with aquatic life, ecological functioning, and human health and welfare. Existing and potential beneficial uses are designated for individual waterbodies in Table 2-1. The federal Antidegradation Policy requires that existing water uses and the level of water quality necessary to protect those uses be maintained and protected[2]. Existing uses are those uses of the waterbody that are attained on or after November 28, 1975, whether or not they are designated in this Basin Plan[3]. Nuisance is defined to mean anything which meets all of the following requirements:

1. Is injurious to health, or is indecent or offensive to the senses, or an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life or property.
2. Affects at the same time an entire community or neighborhood, or any considerable number of persons, although the extent of the annoyance or damage inflicted upon individuals may be unequal.
3. Occurs during, or as a result of, the treatment or disposal of wastes.[4]

3.1.1 Water Quality Objectives

The quality of water is defined by the chemical, physical, biological, bacteriological, radiological, and other properties and characteristics of water which affect its use.[5] There are two types of objectives: narrative and numeric. Narrative objectives present general descriptions of water quality that must be attained through pollutant control measures, watershed management, and restoration actions. They also serve as the basis for the development of detailed numeric objectives. Narrative and numeric water quality objectives define the upper concentration or other limits that the Regional Board considers protective of beneficial uses. The general methodology used in establishing water quality objectives involves, first, designating beneficial water uses; and second, selecting and quantifying the water quality parameters necessary to protect the most vulnerable (sensitive) beneficial uses. Water quality objectives are established to protect beneficial uses and the existing high quality waters of the state. The Regional Water Board may apply more stringent criteria to maintain high-quality waters, as per the state Antidegradation Policy (see below).

It is within the discretion of the Regional Water Board to establish other, or additional, direction on protection of beneficial uses and compliance with objectives of this Basin Plan. To evaluate compliance with water quality objectives, the Regional Water Board will consider all relevant and scientifically valid evidence, including relevant and scientifically valid numeric criteria and guidelines developed and/or published by other agencies and organizations. Generally, numeric values are derived from relevant state or federal laws, regulations, plans, or policies; numeric water quality criteria, standards, or guidelines developed and published by governmental and non-governmental agencies and organizations; and relevant peer-reviewed scientific literature.

Established governmental and non-governmental agencies and organizations include, but are not limited to: California State Water Resources Control Board, California Department of Public Health, California

[1] Wat. Code § 13241
[2] 40 CFR § 131.12(a)(1)
[3] 40 CFR § 131.3(e)
[4] Wat. Code § 13050(m)
[5] Wat. Code § 13050(g)

Office of Environmental Health Hazard Assessment, California Department of Toxic Substances Control, University of California Cooperative Extension, California Department of Fish and Wildlife, U.S. Environmental Protection Agency, U.S. Food and Drug Administration, National Academy of Sciences, U.S. Fish and Wildlife Service, the Food and Agricultural Organization of the United Nations and the World Health Organization. The State Water Board has compiled numeric water quality values from the literature for over 860 chemical constituents in a document entitled *A Compilation of Water Quality Goals*. A searchable *Water Quality Goals* database is accessible on the State Water Board website. The Regional Water Board has compiled water quality values from the literature for sediment-related indices and published them in a peer-reviewed report entitled *Desired Salmonid Freshwater Habitat Conditions for Sediment-Related Indices* (July 2006). This document can be found on the Regional Water Board website. On a case by case basis, the Regional Water Board may collect or request that a discharger collect site specific data or conduct site specific water quality assessments or studies for the purpose of translating the applicable narrative objective into a site specific numeric threshold or thresholds.

The federal Clean Water Act (33 U.S.C. § 303) requires the State to submit to the Administrator of the U.S. Environmental Protection Agency for approval all new or revised water quality standards which are established for surface and ocean waters. Under federal terminology, water quality standards consist of the beneficial uses enumerated in Table 2-1 and the water quality objectives contained in this section. The water quality objectives contained herein are designed to satisfy all state and federal requirements. **Deleted text is being relocated)**

As new information becomes available, the Regional Water Board will review the appropriateness of the objectives contained herein. These objectives will be subject to public hearing at least once during each three-year period following adoption of this Basin Plan to determine the need for review and modification as appropriate **Deleted text is being relocated)**
The water quality objectives contained herein are a compilation of objectives once adopted by the State Water Board, the Regional Water Board, and other state and federal agencies are applicable to several classes of water (see Chapter 2 for a description of classes of water). Other water quality objectives [e.g., taste and odor thresholds or other secondary Maximum Contaminant Levels (MCLs)] and policies (e.g., State Water Board *Policies and Procedures for Investigation and Cleanup and Abatement of Discharges Under Water Code Section* 13304) may apply and that may be more stringent. Whenever several different objectives exist for the same water quality parameter, the strictest objective applies. Where more than one objective exists for the same water quality parameter, the objective protective of the most sensitive beneficial use applies. , tThe State Water Board's "*Policy With Respect to Maintaining High Quality Waters in California*" commonly referred to as the state Antidegradation Policy applies to all classes of water. also applies. The state policy incorporates the federal Antidegradation Policy, where the federal Antidegradation Policy is applicable.

The State Water Board also adopts water quality control plans for application statewide. Water quality control plans adopted by the State Water Board are applicable in the North Coast Region independent of the Basin Plan and supercede duplicative requirements established in the Basin Plan. The Enclosed Bays and Estuaries Plan, the Ocean Plan, and the Thermal Plan are examples of water quality control plans adopted by the State Water Resources Control Board (see the State Water Board website).

The Regional Water Board reviews the Basin Plan including the water quality objectives every three years during the Triennial Review period to evaluate the need for appropriate modification. The Triennial Review process is described in the Introduction to the Basin Plan (Chapter 1). As part of the state's continuing planning process, data will beis collected and numeric water quality objectives will be developed where sufficient information is presently not available for the establishment of such objectives. **Relocated text)**

Controllable water quality factors shall conform to the water quality objectives contained herein. When other factors result in the degradation of water quality beyond the levels or limits established herein as water quality objectives, then controllable factors shall not cause further degradation of water quality. Controllable water quality factors are those actions, conditions, or circumstances resulting from man's activities that may influence the quality of the waters of the State and that may be reasonably controlled. **Deleted text is being**

relocated to Chapter 4 Implementation Plans)

~~Water quality objectives form the basis for establishment of waste discharge requirements, waste discharge prohibitions, or maximum acceptable cleanup standards for all individuals and dischargers.~~

~~These water quality objectives are considered to be necessary to protect those present and probable future beneficial uses enumerated in Table 2-1 and to protect existing high quality waters of the State. These objectives will be achieved primarily through the establishment of waste discharge requirements and through the implementation of this Basin Plan. The appropriate numeric water quality provisions will be established in waste discharge orders.~~

~~The Regional Water Board, in setting waste discharge requirements, will consider, among other things, the potential impact on beneficial uses within the area of influence of the discharge, the existing quality of receiving waters, and the appropriate water quality objectives. The Regional Water Board will make a finding as to the beneficial uses to be protected within the area of influence of the discharge and establish waste discharge requirements to protect those uses and to meet water quality objectives. Resolution Nos. 87-113, 89-131, and 92-135 describe the policy of the Regional Water Board regarding the specific types of waste discharge for which it will waive issuance of waste discharge requirements. These resolutions are included in the Appendix Section of this Plan.~~

~~The water quality objectives for the Region refer to several classes of waters. Ocean waters are waters of the Pacific Ocean outside of enclosed bays, estuaries, and coastal lagoons, and within the territorial (3 mile) limit. Bays are indentations along the coast which include oceanic waters within distinct headlands or harbor works whose narrowest opening is less than 75 percent of the greatest dimension of the enclosed portion of the bay; this definition includes only Crescent City Harbor in the Klamath River Basin, and Humboldt Bay and Bodega Bay in the North Coastal Basin. Estuaries are waters at the mouths of streams which serve as mixing zones for freshwater and seawater; they generally extend from the upstream limit of tidal action to a bay or open ocean. The principal estuarine areas of the Region are at the mouths of the Smith and Klamath Rivers, Lakes Earl and Talawa, and at the mouths of the Eel, Noyo, and Russian Rivers. Inland waters include all surface waters and groundwaters of the basin not included in the definitions of ocean waters, enclosed bays, or estuaries. Interstate waters include all rivers, streams, and lakes which flow across or form part of a state boundary.~~ **(**~~Groundwaters are any subsurface bodies of water which are beneficially used or usable. They include perched water if such water is used or usable or is hydraulically continuous with used or usable water.~~ **Deleted text is being relocated to footnotes 6 & 7)**

~~The water quality objectives which follow supersede and replace those contained in the 1971 "Interim Water Quality Control Plan for the Klamath River Basin," the 1967 "Water Quality Control Policy for the Klamath River in California," the 1967 "Water Quality Control Policy for the Smith River in California," the 1967 "Water Quality Control Policy for the Humboldt-Del Norte Coastal Waters," the 1969 "Water Quality Control Policy for the Lost River," the 1971 "Interim Water Quality Control Plan for the North Coastal Basin," the 1967 "Water Quality Control Policy for the Sonoma-Mendocino Coast," the 1975 "Water Quality Control Plan for the Klamath River Basin (1A)," the 1975 "Water Quality Control Plan for the North Coastal Basin (1B)," and the 1988 "Water Quality Control Plan for the North Coast Region".~~

3.1.2 Water Quality Standards

The federal Clean Water Act defines “water quality standards” to include “designated uses” (i.e., beneficial uses), “water quality criteria” (i.e., water quality objectives), and an antidegradation policy. The beneficial uses in Chapter 2 of this Basin Plan, the water quality objectives contained in this Chapter, and the *Statement of Policy with Respect to Maintaining High Quality Waters in California*, as described below, are this region's water quality standards for purposes of the Clean Water Act.

3.1.3 Water Quality Objectives and Effluent Limitations

It is important to recognize the distinction between ambient water quality objectives and "effluent limitations" or "discharge standards", which are conditions in state and federal waste discharge requirements. Effluent limitations are established in permits both to protect water for beneficial uses within the area of the discharge, and to meet or achieve water quality objectives. Compliance with water quality objectives is further detailed in Chapter 4 (Implementation Plans).

3.2 GENERAL OBJECTIVE ANTIDEGRADATION POLICIES

The following objective policies shall apply to all waters of the Region, or as described.

Whenever the existing quality of water is better than the that water quality objectives established herein by water quality objectives, such existing water quality shall be maintained unless otherwise provided by the provisions of the State Water Resources Control Board Resolution No. 68-16, "*Statement of Policy with Respect to Maintaining High Quality of Waters in California*" (state Antidegradation Policy), including any revisions thereto. A copy of this policy is included verbatim in the Appendix Section of this Plan.State Water Resources Control Board (State Board) Resolution No. 68-16 contains the state Antidegradation Policy. It is titled the "Statement of Policy with Respect to Maintaining High Quality Waters in California and is commonly known as "Resolution 68-16." The State Water Board has interpreted Resolution No. 68-16 the state Antidegradation Policy to incorporate the federal Antidegradation Policy where the federal policy applies. (State Board Order WQO 86-17). The state Antidegradation Policy can be found at the State Water Board's website. The federal Antidegradation Policypolicy is found at 40 CFR Section 131.12. The state and federal antidegradation policies are included as Appendices to the Basin Plan. The state and federal antidegradation policies are implemented independent of this Basin Plan provision. A summary of the state and federal antidegradation policies is provided here for the convenience of the reader.
Relocated and modified text)

The state Antidegradation Policy applies more comprehensively to water quality changes than the federal policy. In particular, the state Antidegradation Policypolicy applies to both those groundwaters and surface waters in which whosethe existing water quality meets or exceeds (is better than) water quality objectives. Such groundwaters and surface waters are defined as high quality waters. The state Antidegradation Policypolicy establishes two conditions that must be met before the quality of high quality waters may be lowered by nonpoint or point source waste discharges, whether or not such a discharge is allowed under a new, renewed, or revised permit.

First, the state must determine that lowering the quality of high quality waters:

- 1) Will be consistent with the maximum benefit to the people of the state,
- 2) Will not unreasonably affect present and anticipated beneficial uses of such water, and
- 3) Will not result in water quality less than that prescribed in state policies (e.g., water quality objectives in Water Quality Control Planswater quality control plans).

Second, any activities that result in discharges to high quality waters are required to:

- a) Mmeet waste discharge requirements that will result in the best practicable treatment or control of the discharge necessary to avoid pollution or nuisance and
- b) Mmaintain the highest water quality consistent with the maximum benefit to the people of the state.

If such treatment or control results in a discharge that maintains the existing high water quality, then a less stringent level of treatment or control would not be in compliance with the state Antidegradation Policy68-16.

Likewise, the a discharge to high quality water could not be allowed under Resolution 68-16the state Antidegradation Policy if a) the discharge, even after treatment or control, would unreasonably affect beneficial uses or b) would not comply with applicable provisions of water quality control plans.

The federal Antidegradation Policy applies to surface waters, regardless of the level of existing water quality. Where water quality is better than the minimum necessary to support existing or anticipated instream beneficial uses of surface water, the federal Antidegradation Policypolicy requires that quality to be maintained and protected, unless the state finds, after ensuring public participation, that:

- 1) Such activity is necessary to accommodate important economic or social development in the area in which the waters are located,;
- 2) Water quality is adequate to protect existing beneficial uses fully, ; and,
- 3) The highest statutory and regulatory requirements for all new and existing point source discharges and all cost-effective and reasonable best management practices for non-point source control are achieved.

Under this policythe federal Antidegradation Policy, an activity that results in discharge to surface water would be prohibited if the discharge will would lower the quality of surface waters that do not currently attain water quality standards. Both the state and federal antidegradation policies acknowledge that an activity that results in a minor water quality lowering, even if incrementally small, can result in a violation of antidegradation policies through cumulative effects, especially, for example, when the waste discharge is contains a cumulative, persistent, or bioaccumulative pollutant or pollutants.

The state and federal antidegradation policies are enforceable independent of this Basin Plan provision. The above summary of the state and federal antidegradation policies is provided merely for the convenience of the reader. **Text modified and relocated above)**

3.3 WATER QUALITY OBJECTIVES FOR OCEAN WATERS

The provisions of the State Water Board's "*Water Quality Control Plan for Ocean Waters of California*" (Ocean Plan),) and "*Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California*" (Thermal Plan),) and any revisions thereto shall apply. Copies of these to ocean waters within the North Coast Region. These plans are included verbatim in the Appendix Section of this Plancan be found at the State Water Board website.

3.4 WATER QUALITY OBJECTIVES FOR INLAND SURFACE WATERS, ENCLOSED BAYS, AND ESTUARIES

Federal water quality criteria contained in the National Toxics Rule[6] (NTR) and the California Toxics Rule[7] (CTR) and any revisions thereto address human health and aquatic life protection and shall apply to inland surface waters, enclosed bays, and estuaries of the North Coast Region. NTR and CTR water quality criteria are implemented through the provisions of the State Water Board's *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (SIP). This policy can be found at the State Water Board website. These provisions are incorporated by reference into this Basin Plan. This incorporation by reference is prospective, including future changes to the incorporated provisions as the changes take effect.

[6] 40 C.F.R. § 131.36.
[7] 40 C.F.R. § 131.38.

In addition to, the General Objective Antidegradation Policy, the waterbody-specific objectives contained in Tables 3-1, 3-1a, and 3-1b, and the following objectives shall apply for to inland surface waters, enclosed bays, and estuaries of the North Coast Region. The water quality objectives are presented below.

3.4.1 Bacteria

The bacteriological quality of waters of the North Coast Region shall not be degraded beyond natural background levels. In no case shall coliform concentrations in waters of the North Coast Region exceed the following:

In waters designated for contact recreation (REC-1), the median fecal coliform concentration based on a minimum of not less than five samples for any 30-day period shall not exceed 50/100 ml, nor shall more than ten percent of total samples during any 30-day period exceed 400/100 ml (State Department of Health Services State Water Board Division of Drinking Water).

At all areas where shellfish may be harvested for human consumption (SHELL), the fecal coliform concentration throughout the water column shall not exceed 43/100 ml for a 5-tube decimal dilution test or 49/100 ml when a three-tube decimal dilution test is used (National Shellfish Sanitation Program, *Manual of Operation*).

3.4.2 Biostimulatory Substances

Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.

3.4.3 Chemical Constituents

In no case shall Wwaters designated for use as agricultural supply (AGR) shall not contain concentrations of chemical constituents in amounts which that cause nuisance or adversely affect such beneficial uses.

Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the limits specified in California Code of Regulations, Title 22, Chapter 15, Division 4, Article 4, Section 64435 (Tables 2 and 3), and Section 64444.5 (Table 5), and listed in Table 3-2 of this Plan. following maximum contaminant level (MCL) and secondary maximum contaminant level (SMCL) provisions specified in Title 22 of the California Code of Regulations:

- Table 64431-A, MCLs - Inorganic Chemicals (§ 64431)
- Table 64444-A, MCLs - Organic Chemicals (§ 64444)
- Table 64449-A, SMCLs - "Consumer Acceptance Contaminant Levels" (§ 64449)
- Table 64449-B, SMCLs - "Consumer Acceptance Contaminant Level Ranges" (§ 64449)
- Table 64442, Radionuclide Maximum Containment Levels and Detection Levels for Purposes of Reporting (DLRs) (§ 64442)
- Table 64443, Radionuclide Maximum Contaminant Levels and
- DLRs (§ 64443)

These provisions are incorporated by reference into this Basin Plan. This incorporation by reference is prospective, including future changes to the incorporated provisions as the changes take effect.

Waters designated for use as agricultural supply (AGR) shall not contain concentrations of

~~chemical constituents in amounts which cause nuisance or adversely affect such beneficial uses.~~
Relocated & Revised Above)

Numerical water quality objectives for individual waters are contained in Table 3-1, 3-1a, and 3-1b.

3.4.4 Color

Waters shall be free of coloration that causes nuisance or adversely affects beneficial uses.

3.4.5 Dissolved Oxygen

Dissolved oxygen (DO) concentrations shall conform to the following aquatic life requirements. ~~limits listed in Table 3-1 and 3-1a. For waters not listed in Table 3-1 or 3-1a, and where dissolved oxygen objectives are not prescribed, the dissolved oxygen concentrations shall not be reduced below the following minimum levels at any time.~~

~~Waters designated WARM, MAR, or SAL……………………………………….5.0 mg/L~~
~~Waters designated COLD…………………………………………………………6.0 mg/L~~
~~Waters designated SPWN…………………………………………………………7.0 mg/L~~
~~Waters designated SPWN during critical spawning and egg incubation periods………………………………………….9.0 mg/L~~

Beneficial Use	Daily Minimum Objective (mg/L)	7-Day Average Objective (mg/L)[8]
MAR, SAL	5.0	NA
WARM	5.0	6.0
COLD[9]	6.0	8.0
SPWN[10]	9.0	11.0

Dissolved oxygen concentrations in Humboldt Bay and Bodega Bay shall conform to a daily minimum objective of 6.0 mg/L. As required by the Ocean Plan, dissolved oxygen concentrations in ocean waters shall not at any time be depressed more than 10 percent from that which occurs naturally in ocean waters.

Upon approval from the Executive Officer, in those waterbodies for which the aquatic life-based DO requirements are unachievable due to natural conditions[11], site specific background DO requirements can be applied as water quality objectives by calculating the daily minimum DO necessary to maintain 85% DO saturation during the dry season and 90% DO saturation during the wet season under site salinity, site atmospheric pressure, and natural receiving water temperatures.[12] In no event may controllable factors reduce the daily minimum DO below 6.0 mg/L.

For the protection of estuarine habitat (EST), the dissolved oxygen concentration of enclosed bays and estuaries shall not be depressed to levels adversely affecting beneficial uses as a result of controllable water quality factors.

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[8] A 7-day moving average is calculated by taking the average of each set of seven consecutive daily averages.
[9] Water quality objectives designed to protect COLD-designated waters are based on the aquatic life-based requirements of salmonids but apply to all waters designated in Table 2-1 of the Basin Plan as COLD regardless of the presence or absence of salmonids.
[10] Water quality objectives designed to protect SPWN-designated waters apply to all fresh waters designated in Table 2-1 of the Basin Plan as SPWN in those reaches and during those periods of time when spawning, egg incubation, and larval development are occurring or have historically occurred. The period of spawning, egg incubation, and emergence generally occur in the North Coast Region between the dates of September 15 and June 4.
[11] Natural conditions are conditions or circumstances affecting the physical, chemical, or biological integrity of water that are not influenced by past or present anthropogenic activities.
[12] The method(s) used to estimate natural temperatures for a given waterbody or stream length must be approved by the Executive Officer and may include, as appropriate, comparison with reference streams, simple calculation, or computer models.

Dissolved oxygen concentrations for the Klamath River Watershed shall conform to the waterbody-specific objectives listed in Table 3-1a.

3.4.6 Floating Material

Waters shall not contain floating material, including solids, liquids, foams, and scum, in concentrations that cause nuisance or adversely affect beneficial uses.

3.4.7 Oil and Grease

Waters shall not contain oils, greases, waxes, or other materials in concentrations that result in a visible film or coating on the surface of the water or on objects in the water, that cause nuisance, or that otherwise adversely affect beneficial uses.

3.4.8 Pesticides

Waters shall not contain any No individual pesticide or combination of pesticides shall be present in concentrations that cause nuisance or adversely affect beneficial uses. There shall be no bioaccumulation of pesticide concentrations found in bottom sediments or aquatic life.

Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of pesticides in excess of the numeric limits established in Title 22 and as prospectively incorporated in 3.4.3 Chemical Constituents. the limiting concentrations set forth in California Code of Regulations, Title 22, Division 4, Chapter 15, Article 4, Section 64444.5 (Table 5), and listed in Table 3-2 of this Plan.

3.4.9 pH

The pH shall conform to those limits listed in Table 3-1. For waters not listed in Table 3-1 and where pH objectives are not prescribed, the pH shall not be depressed below 6.5 nor raised above 8.5. Changes in normal ambient pH levels shall not exceed 0.2 units in waters with designated marine habitat (MAR) or inland saline habitat (SAL) beneficial uses nor 0.5 units within the range specified above in fresh waters with designated cold freshwater habitat (COLD) or warm freshwater habitat (WARM) beneficial uses.

3.4.10 Radioactivity

Waters shall not contain rRadionuclides shall not be present in concentrations which are deleterious to human, plant, animal, or aquatic life nor which result in the accumulation of radionuclides in the food web to an extent which presents a hazard to human, plant, animal, or indigenous aquatic life

Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of radionuclides in excess of the numeric limits established in Title 22 and as prospectively incorporated in 3.4.3 Chemical Constituents.

Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of radionuclides in excess of the limits specified in California Code of Regulations, Title 22, Division 4, Chapter 15, Article 4, Section 64443, Table 4, and listed below:

MCL Radioactivity

Constituent	Maximum Contaminant Level, pCi/L
Combined Radium 226 and Radium 228	5
Gross Alpha particle activity	15

(including Radium 226 but excluding Radon and Uranium)
Tritium 20,000
Strontium 90 8
Gross Beta particle activity 50
Uranium........ 20

3.4.11 Sediment

The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.

3.4.12 Settleable Material

Waters shall not contain substances in concentrations that result in deposition of material that causes nuisance or adversely affect beneficial uses.

3.4.13 Suspended Material

Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.

3.4.14 Tastes and Odors

Waters shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin, or that cause nuisance or adversely affect beneficial uses.

Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemicals in excess of the numeric taste and odor limits established in Title 22 and as prospectively incorporated in 3.4.3 Chemical Constituents. Numeric water quality objectives with regards to taste and odor thresholds have been developed by the State Department of Health Services and the U.S. EPA. These numeric objectives, as well as those available in the technical literature, are incorporated into waste discharge requirements and cleanup and abatement orders as appropriate.

3.4.15 Temperature

Temperature objectives for COLD interstate waters, associated with cold freshwater habitat (COLD), warm freshwater habitat (WARM interstate waters), enclosed bays, and Enclosed Bays and Estuariesestuaries are as specified in the "State Water Board *Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays of California*" (Thermal Plan) including any revisions thereto. A copy of this plan The Thermal Plan is included verbatim in the Appendix Section of this Plan. available at the State Water Board website.

In addition, the following temperature objectives apply to surface waters:

The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses.

At no time or place shall the temperature of any waters associated with cold freshwater habitat (COLD water) be increased by more than 5°F above natural receiving water temperature.

At no time or place shall the temperature of WARM intrastate waters associated with warm freshwater habitat (WARM) be increased more than 5°F above natural receiving water temperature.

Waterbody-specific objectives for temperature in the Upper Trinity River are listed in Table 3-1b.

3.4.16 Toxicity

~~All w~~Waters shall ~~be maintained free of~~ not contain toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life. This objective applies regardless of whether the toxicity is caused by a single substance or the synergistic effect of multiple substances. Compliance with this objective ~~will~~ shall be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, bioassays of appropriate duration, or other appropriate methods as specified by the Regional Water Board.

The survival of aquatic life in surface waters subjected to a waste discharge, or other controllable water quality factors, shall not be less than that for the same ~~water body~~ waterbody in areas unaffected by the waste discharge, or when necessary for other control water that is consistent with the requirements for "experimental water" as described in ~~"Standard Methods for the Examination of Water and Wastewater", 18th Edition (1992).~~ *Standard Methods for the Examination of Water and Wastewater,* latest edition (American Public Health Association, et al.). As a minimum, compliance with this objective ~~as stated in the previous sentence~~ shall be evaluated with a 96-hour bioassay.

In addition, effluent limits based upon ~~acute~~ bioassays of effluents will be prescribed~~.~~, ~~W~~where appropriate~~,~~. ~~a~~Additional numeric~~al~~ receiving water objectives for specific toxicants will be established as sufficient data become available~~,~~ and source control of toxic substances ~~will~~ may be ~~encouraged~~ required.

3.4.17 Turbidity

Turbidity shall not be increased more than 20 percent above naturally occurring background levels. Allowable zones of dilution within which higher percentages can be tolerated may be defined for specific discharges upon the issuance of discharge permits or waiver thereof.

3.5 WATER QUALITY OBJECTIVES FOR GROUNDWATERS

~~**General Objectives**~~

Groundwater objectives consist primarily of narrative objectives combined with a limited number of numeric objectives. The following objectives shall apply to groundwaters[13] of the North Coast Region. Waterbody-specific objectives contained in Table 3-1 also apply.

Under existing law, the Water Board regulates waste discharges to land that could affect water quality, including both groundwater and surface water quality. Waste discharges that reach groundwater are regulated to protect both groundwater and any surface water in continuity with groundwater. Waste discharges that affect groundwater that is in continuity with surface water cannot cause violations of any applicable groundwater or surface water standards.

3.5.1 Bacteria

In groundwaters used for domestic or municipal supply (MUN), the median of the most probable number of coliform organisms over any 7-day period shall be less than 1.1 MPN/100 ml, less than 1 colony/100 ml, or absent (~~State Department of Health Services~~ State Water Board Division of Drinking Water).

[13] Groundwater is defined as subsurface water in soils and geologic formations that are fully saturated all or part of the year. (Groundwater is any subsurface bodies of water which is beneficially used or usable. **Relocated text)**

3.5.2 Chemical Constituents

In no case shall g~~G~~roundwaters ~~used for domestic or municipal supply (MUN) shall not~~ contain concentrations of chemical constituents ~~in excess of the limits specified in California Code of Regulations, Title 22, Division 4, Chapter 15, Article 4, Section 64435 Tables 2 and 3, and Section 64444.5 (Table 5) and listed in Table 3-2 of this Plan.~~
~~Groundwaters used for agricultural supply (AGR) shall not contain concentrations of chemical constituents~~ in amounts that cause nuisance or adversely affect ~~such~~ beneficial uses.

Groundwaters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the following maximum contaminant level (MCL) and secondary maximum contaminant level (SMCL) provisions specified in Title 22 of the California Code of Regulations:

- Table 64431-A, MCLs - Inorganic Chemicals (§ 64431)
- Table 64444-A, MCLs - Organic Chemicals (§ 64444)
- Table 64449-A, SMCLs - "Consumer Acceptance Contaminant Levels" (§ 64449)
- Table 64449-B, SMCLs - "Consumer Acceptance Contaminant Level Ranges" (§ 64449)
- Table 64442, Radionuclide MCLs and Detection Levels for Purposes of Reporting (DLRs) (§ 64442)
- Table 64443, Radionuclide MCLs and
- DLRs (§ 64443)

These provisions are incorporated by reference into this Basin Plan. This incorporation by reference is prospective, including future changes to the incorporated provisions as the changes take effect.

Groundwater-specific n~~N~~umeric~~al~~ objectives for ~~certain constituents for~~ individual groundwaters are contained in Table 3-1.~~ As part of the state's continuing planning process, data will be collected and numerical water quality objectives will be developed for those mineral and nutrient constituents where sufficient information is presently not available for the establishment of such objectives.~~ **(Relocated to introduction)**

3.5.3 Radioactivity

Groundwaters ~~used for domestic or municipal supply (MUN)~~ shall not contain concentrations of radionuclides in ~~excess of the limits specified in California Code of Regulations, Title 22, Division 4, Chapter 15, Article 5, Section 64443, Table 4 and listed in Table 3-2 of this Plan~~ concentrations that cause nuisance or adversely affect beneficial uses.

Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of radionuclides in excess the numeric limits established in Title 22 and as prospectively incorporated in 3.5.2 Chemical Constituents.

3.5.4 Tastes and Odors

Groundwaters shall not contain taste- or odor-producing substances in concentrations that cause nuisance or adversely affect beneficial uses.

Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemicals in excess of the numeric taste and odor limits established in Title 22 and as prospectively incorporated in 3.5.2 Chemical Constituents.

Numeric water quality objectives have been developed by the State Department of Health Services and U.S. EPA. These numeric objectives, as well as those available in the technical literature, are incorporated into waste discharge requirements and cleanup and abatement orders as appropriate.

3.5.5 Toxicity

Groundwaters shall not contain toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, humans or aquatic life[14] or that adversely impact beneficial uses. This objective applies regardless of whether the toxicity is caused by a single substance or the synergistic effect of multiple substances.

COMPLIANCE WITH WATER QUALITY OBJECTIVES

The Regional Water Board recognizes that immediate compliance with new effluent and/or receiving water NPDES permit limitations based on new, revised or newly interpreted water quality objectives or prohibitions adopted by the Regional Water Board or the State Water Resources Control Board, or with new, revised or newly interpreted water quality criteria promulgated by the U.S. Environmental Protection Agency (USEPA)[1], may not be technically and/or economically feasible[2] in all circumstances. **Deleted text is being relocated to Chapter 4 Implementation Plans)**

Where the Regional Water Board determines that it is infeasible for an existing discharger[3] to immediately comply with NPDES permit effluent limitations or where appropriate, receiving water limitations, specified to implement new, revised or newly interpreted water quality objectives, criteria or prohibitions; issuance of a schedule of compliance[4] may be appropriate

Similarly, immediate compliance may not be technically and/or economically feasible for existing non-NPDES dischargers that, under new interpretation of law, are newly required to comply with new NPDES permitting requirements. Issuance of a schedule of compliance may be appropriate in these circumstances as well, to comply with effluent and/or receiving water limitations specified to implement objectives, criteria, or prohibitions that are adopted, revised, or reinterpreted after July 1, 1977, and that were not included in the non-NPDES permit.

Any schedule of compliance shall require achievement of the effluent limitations and/or receiving water limitations within the shortest feasible period of time, **Deleted text is being relocated to Chapter 4 Implementation Plans)** taking into account the factors identified in Chapter 4 for the implementation of schedules of compliance. All schedules of compliance will be limited to the time frames set out in Chapter 4.

[14] The application of numeric values protective of aquatic life may be necessary where groundwater is hydraulically connected with surface waters. Groundwater includes perched water if such water is used or usable or is hydraulically continuous with used or usable water. **Relocated text**

[1] New, revised, or newly interpreted water quality objectives, criteria, or prohibitions means: 1) objectives as defined in Section 13050(h) of Porter-Cologne; 2) criteria as promulgated by the USEPA; or 3) prohibitions as defined in the Water Quality Control Plan for the North Coast Region that are adopted, revised, or newly interpreted after November 29, 2006. Objectives and criteria may be narrative or numeric.

[2] Technical and economic feasibility shall be determined consistent with State Board Resolution No. 92-49.

[3] Existing discharger as defined in the State "Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California," (CTR-SIP) means: any discharger (non-NPDES or NPDES) that is not a new discharger. An existing discharger includes an increasing discharger (i.e., an existing facility, with treatment systems in place for its current discharge that is or will be expanding, upgrading, or modifying its existing permitted discharge after November 29, 2006). A new discharger includes any building, structure, facility, or installation from which there is, or may be, a discharge of pollutants, the construction of which commenced after November 29, 2006.

[4] Schedule of compliance: as defined in Section 502 (17) of the Clean Water Act, means: a schedule of remedial measures including an enforceable sequence of actions or operations leading to compliance with an effluent limitation, other limitation, prohibition, or standard.

TABLE 3-1
SPECIFIC WATER QUALITY OBJECTIVES FOR THE NORTH COAST REGION

Waterbody[1]	Specific Conductance (micromhos) @ 77°F		Total Dissolved Solids (mg/L)		~~Dissolved Oxygen (mg/L)~~			Hydrogen Ion (pH)		Hardness (mg/L)	Boron (mg/L)	
	90% Upper Limit[3]	50% Upper Limit[2]	90% Upper Limit[3]	50% Upper Limit[2]	~~Min~~	~~90% Upper Limit[3]~~	~~50% Upper Limit[2]~~	Max	Min	50% Upper Limit[2]	90% Upper Limit[3]	50% Upper Limit[2]
Lost River HA												
Clear Lake Reservoir & Upper Lost River	300	200			~~5.0~~		~~8.0~~	9.0	7.0	60	0.5	0.1
Lower Lost River	1000	700			~~5.0~~		~~-~~	9.0	7.0	-	0.5	0.1
Other Streams	250	150			~~7.0~~		~~8.0~~	8.4	7.0	50	0.2	0.1
Tule Lake	1300	900			~~5.0~~		~~-~~	9.0	7.0	400	-	-
Lower Klamath Lake	1150	850			~~5.0~~		~~-~~	9.0	7.0	400	-	-
Groundwaters[4]	1100	500			~~-~~		~~-~~	8.5	7.0	250	0.3	0.2
Butte Valley HA												
Streams	150	100			~~7.0~~		~~9.0~~	8.5	7.0	30	0.1	0.0
Meiss Lake	2000	1300			~~7.0~~		~~8.0~~	9.0	7.5	100	0.3	0.1
Groundwaters[4]	800	400			~~-~~		~~-~~	8.5	6.5	120	0.2	0.1
Shasta Valley HA												
Shasta River	800	600			~~7.0~~		~~9.0~~	8.5	7.0	220	1.0	0.5
Other Streams	700	400			~~7.0~~		~~9.0~~	8.5	7.0	200	0.5	0.1
Lake Shastina	300	250			~~6.0~~		~~9.0~~	8.5	7.0	120	0.4	0.2
Groundwaters[4]	800	500			~~-~~		~~-~~	8.5	7.0	180	1.0	0.3
Scott River HA												
Scott River	350	250			~~7.0~~		~~9.0~~	8.5	7.0	100	0.4	0.1
Other Streams	400	275			~~7.0~~		~~9.0~~	8.5	7.0	120	0.2	0.1
Groundwaters[4]	500	250			~~-~~		~~-~~	8.0	7.0	120	0.1	0.1
Salmon River HA												
All Streams	150	125			~~9.0~~		~~10.0~~	8.5	7.0	60	0.1	0.0

TABLE 3-1 SPECIFIC WATER QUALITY OBJECTIVES FOR THE NORTH COAST REGION												
Waterbody[1]	Specific Conductance (micromhos) @ 77°F		Total Dissolved Solids (mg/L)		~~Dissolved Oxygen (mg/L)~~			Hydrogen Ion (pH)		Hardness (mg/L)	Boron (mg/L)	
	90% Upper Limit[3]	50% Upper Limit[2]	90% Upper Limit[3]	50% Upper Limit[2]	~~Min~~	~~90% Upper Limit[3]~~	~~50% Upper Limit[2]~~	Max	Min	50% Upper Limit[2]	90% Upper Limit[3]	50% Upper Limit[2]
Middle Klamath River HA												
Klamath River above Iron Gate Dam including Iron Gate & Copco Reservoirs [12]	425	275			~~[13]~~		~~[13]~~	8.5	7.0	60	0.3	0.2
Klamath River below Iron Gate Dam [12]	350	275			~~[13]~~		~~[13]~~	8.5	7.0	80	0.5	0.2
Other Streams	300	150			~~7.0~~		~~9.0~~	8.5	7.0	60	0.1	0.0
Groundwaters[4]	750	600			~~-~~		~~-~~	8.5	7.5	200	0.3	0.1
Applegate River HA												
All Streams	250	175			~~7.0~~		~~9.0~~	8.5	7.0	60	-	-
Upper Trinity River HA												
Trinity River	200	175			~~7.0~~		~~10.0~~	8.5	7.0	80	0.1	0.0
Other Streams	200	150			~~7.0~~		~~10.0~~	8.5	7.0	60	0.0	0.0
~~Clair Engle~~ Trinity Lake & Lewiston Reservoir	200	150			~~7.0~~		~~10.0~~	8.5	7.0	60	0.0	0.0
Hayfork Creek												
Hayfork Creek	400	275			~~7.0~~		~~9.0~~	8.5	7.0	150	0.2	0.1
Other Streams	300	250			~~7.0~~		~~9.0~~	8.5	7.0	125	0.0	0.0
Ewing Reservoir	250	200			~~7.0~~		~~9.0~~	8.0	6.5	150	0.1	0.0
Groundwaters[4]	350	225			~~-~~		~~-~~	8.5	7.0	100	0.2	0.1
S.F. Trinity River HA												
S.F. Trinity River	275	200			~~7.0~~		~~10.0~~	8.5	7.0	100	0.2	0.0

TABLE 3-1
SPECIFIC WATER QUALITY OBJECTIVES FOR THE NORTH COAST REGION

Waterbody[1]	Specific Conductance (micromhos) @ 77°F		Total Dissolved Solids (mg/L)		~~Dissolved Oxygen (mg/L)~~			Hydrogen Ion (pH)		Hardness (mg/L)	Boron (mg/L)	
	90% Upper Limit[3]	50% Upper Limit[2]	90% Upper Limit[3]	50% Upper Limit[2]	~~Min~~	~~90% Upper Limit[3]~~	~~50% Upper Limit[2]~~	Max	Min	50% Upper Limit[2]	90% Upper Limit[3]	50% Upper Limit[2]
Other Streams	250	175			~~7.0~~		~~9.0~~	8.5	7.0	100	0.0	0.0
Lower Trinity River HA												
Trinity River	275	200			~~8.0~~		~~10.0~~	8.5	7.0	100	0.2	0.0
Other Streams	250	200			~~9.0~~		~~10.0~~	8.5	7.0	100	0.1	0.0
Groundwaters[4]	200	150			~~-~~		~~-~~	8.5	7.0	75	0.1	0.1
Lower Klamath River HA												
Klamath River[12]	300[56]	200[56]			~~13~~		~~13~~	8.5	7.0	75[65]	0.5[65]	0.2[65]
Other Streams	200[65]	125[65]			~~8.0~~		~~10.0~~	8.5	6.5	25[65]	0.1[65]	0.0[65]
Groundwaters[4]	300	225			~~-~~		~~-~~	8.5	6.5	100	0.1	0.0
Illinois River HA												
All Streams	200	125			~~8.0~~		~~10.0~~	8.5	7.0	75	0.1	0.0
Winchuck River HU												
All Streams	200[65]	125[65]			~~8.0~~		~~10.0~~	8.5	7.0	50[65]	0.0[65]	0.0[65]
Smith River HU												
Smith River-Main Forks	200	125			~~8.0~~		~~11.0~~	8.5	7.0	60	0.1	0.1
Other Streams	150[65]	125[65]			~~7.0~~		~~10.0~~	8.5	7.0	60[65]	0.1[65]	0.0[65]
Smith River Plain HSA												
Smith River	200[65]	150[65]			~~8.0~~		~~11.0~~	8.5	7.0	60[65]	0.1[65]	0.0[65]
Other Streams	150[65]	125[65]			~~7.0~~		~~10.0~~	8.5	6.5	60[65]	0.1[65]	0.0[65]
Lakes Earl & Talawa	-	-			~~7.0~~		~~9.0~~	8.5	6.5	-	-	-
Groundwaters[4]	350	100			~~-~~		~~-~~	8.5	6.5	75	1.0	0.0
~~Crescent City Harbor~~	~~-~~	~~-~~										

TABLE 3-1
SPECIFIC WATER QUALITY OBJECTIVES FOR THE NORTH COAST REGION

Waterbody[1]	Specific Conductance (micromhos) @ 77°F		Total Dissolved Solids (mg/L)		~~Dissolved Oxygen (mg/L)~~			Hydrogen Ion (pH)		Hardness (mg/L)	Boron (mg/L)	
	90% Upper Limit[3]	50% Upper Limit[2]	90% Upper Limit[3]	50% Upper Limit[2]	~~Min~~	~~90% Upper Limit[3]~~	~~50% Upper Limit[2]~~	Max	Min	50% Upper Limit[2]	90% Upper Limit[3]	50% Upper Limit[2]
Redwood Creek HU												
Redwood Creek	220[65]	125[65]	115[65]	75[65]	~~7.0~~	~~7.5~~	~~10.0~~	8.5	6.5			
Mad River HU												
Mad River	300[65]	150[65]	160[65]	90[65]	~~7.0~~	~~7.5~~	~~10.0~~	8.5	6.5			
Eureka Plain HU												
Humboldt Bay	-	-	-	-	~~6.0~~	~~6.2~~	~~7.0~~	8.5	Footnote ~~7~~6			
Eel River HU												
Eel River	375[65]	225[65]	275[65]	140[65]	~~7.0~~	~~7.5~~	~~10.0~~	8.5	6.5			
Van Duzen River	375	175	200	100	~~7.0~~	~~7.5~~	~~10.0~~	8.5	6.5			
South Fork Eel River	350	200	200	120	~~7.0~~	~~7.5~~	~~10.0~~	8.5	6.5			
Middle Fork Eel River	450	200	230	130	~~7.0~~	~~7.5~~	~~10.0~~	8.5	6.5			
Outlet Creek	400	200	230	125	~~7.0~~	~~7.5~~	~~10.0~~	8.5	6.5			
Cape Mendocino HU												
Bear River	390[65]	255[65]	240[65]	150[65]	~~7.0~~	~~7.5~~	~~10.0~~	8.5	6.5			
Mattole River	300[65]	170[65]	170[65]	105[65]	~~7.0~~	~~7.5~~	~~10.0~~	8.5	6.5			
Mendocino Coast HU												
Ten Mile River	-	-	-	-	~~7.0~~	~~7.5~~	~~10.0~~	8.5	6.5			
Noyo River	185[65]	150[65]	120[65]	105[65]	~~7.0~~	~~7.5~~	~~10.0~~	8.5	6.5			
Jug Handle Creek	-	-	-	-	~~7.0~~	~~7.5~~	~~10.0~~	8.5	6.5			
Big River	300[65]	195[65]	190[65]	130[65]	~~7.0~~	~~7.5~~	~~10.0~~	8.5	6.5			
Albion River	-	-	-	-	~~7.0~~	~~7.5~~	~~10.0~~	8.5	6.5			
Navarro River	285[65]	250[65]	170[65]	150[65]	~~7.0~~	~~7.5~~	~~10.0~~	8.5	6.5			
Garcia River	-	-	-	-	~~7.0~~	~~7.5~~	~~10.0~~	8.5	6.5			
Gualala River	-	-	-	-	~~7.0~~	~~7.5~~	~~10.0~~	8.5	6.5			
Russian River HU												

TABLE 3-1
SPECIFIC WATER QUALITY OBJECTIVES FOR THE NORTH COAST REGION

Waterbody[1]	Specific Conductance (micromhos) @ 77°F		Total Dissolved Solids (mg/L)		~~Dissolved Oxygen (mg/L)~~			Hydrogen Ion (pH)		Hardness (mg/L)	Boron (mg/L)	
	90% Upper Limit[3]	50% Upper Limit[2]	90% Upper Limit[3]	50% Upper Limit[2]	~~Min~~	~~90% Upper Limit[3]~~	~~50% Upper Limit[2]~~	Max	Min	50% Upper Limit[2]	90% Upper Limit[3]	50% Upper Limit[2]
(upstream)[7 ~~8~~]	320	250	170	150	~~7.0~~	~~7.5~~	~~10.0~~	8.5	6.5			
(downstream)[8 ~~9~~]	375[~~6~~5]	285[~~6~~5]	200[~~6~~5]	170[~~6~~5]	~~7.0~~	~~7.5~~	~~10.0~~	8.5	6.5			
Laguna de Santa Rosa	-	-	-	-	~~7.0~~	~~7.5~~	~~10.0~~	8.5	6.5			
Bodega Bay	-	-	-	-	~~6.0~~	~~6.2~~	~~7.0~~	8.5	Footnote ~~7~~6			
Coastal Waters[~~10~~9]	-	-	-	-	~~11~~	~~11~~	~~11~~	Footnote ~~12~~11	Footnote ~~12~~11			

1 Water~~-~~bodies are grouped by hydrologic unit (HU), hydrologic area (HA), or hydrologic subarea (HSA).
2 50% upper and lower limits represent the 50 percentile values of the monthly means for a calendar year. 50% or more of the monthly means must be less than or equal to an upper limit and greater than or equal to a lower limit.
3 90% upper and lower limits represent the 90 percentile values for a calendar year. 90% or more of the values must be less than or equal to an upper limit and greater than or equal to a lower limit.
4 Value may vary depending on the aquifer being sampled. This value is the result of sampling over time, and as pumped, from more than one aquifer.
~~5 Daily Average Not to Exceed — Period — River Reach~~
~~60°F — July 1 - Sept. 14 — Lewiston Dam to Douglas City Bridge~~
~~56°F — Sept. 15 - Oct. 1 — Lewiston Dam to Douglas City Bridge~~
~~56°F — Oct. 1 - Dec. 31 — Lewiston Dam to confluence of North Fork Trinity River~~
5~~6~~ Does not apply to estuarine areas.
6~~7~~ pH shall not be depressed below natural background levels.
7~~8~~ Russian River (upstream) refers to the mainstem river upstream of its confluence with Laguna de Santa Rosa.
8~~9~~ Russian River (downstream) refers to the mainstem river downstream of its confluence with Laguna de Santa Rosa.
9~~10~~ The State Water Board Ocean Plan applies to all North Coast Region coastal waters.
10~~11~~ Dissolved oxygen concentrations shall not at any time be depressed more than 10 percent from that which occurs naturally.
11~~12~~ pH shall not be changed at any time more than 0.2 units from that which occurs naturally.
12~~13~~ The ~~Site~~ Waterbody Specific Objectives (W~~S~~SOs) for dissolved oxygen (DO) have been recalculated for the mainstem Klamath River and are presented separately in Table 3-1a.
\- no water~~-~~body specific objective available.

TABLE 3-1a[1]
WATERBODY-SPECIFIC OBJECTIVES FOR
DISSOLVED OXYGEN (DO) IN THE MAINSTEM KLAMATH RIVER

Location[2]	Percent DO Saturation Based On Natural Receiving Water Temperatures[3]	Time Period
Stateline to the Scott River	90%	October 1 through March 31
	85%	April 1 through September 30
Scott River to Upstream Hoopa-California boundary	90%	Year round
Downstream ~~of~~ Hoopa-California boundary to Turwar	85%	June 1 through August 31
	90%	September 1 through May 31
Upper and Middle Estuary	80%	August 1 through August 31
	85%	September 1 through October 31 and June 1 through July 31
	90%	November 1 through May 31
Lower Estuary	For the protection of estuarine habitat (EST), the dissolved oxygen content of the lower estuary shall not be depressed to levels adversely affecting beneficial uses as a result of controllable water quality factors.	

1 States may establish ~~site~~ waterbody- specific objectives equal to natural background (USEPA, 1986. Ambient Water Quality Criteria for Dissolved Oxygen, EPA 440/5-86-033; USEPA Memo from Tudor T. Davies, Director of Office of Science and Technology, USEPA Washington, D.C. dated November 5, 1997). For aquatic life uses, where the natural background condition for a specific parameter is documented, by definition that condition is sufficient to support the level of aquatic life expected to occur naturally at the site absent any interference by humans (Davies, 1997). These DO objectives are derived from the T1BSR run of the Klamath TMDL model and described in Tetra Tech, December 23, 2009 *Modeling Scenarios: Klamath River Model for TMDL Development.* They represent natural DO background conditions due only to non-anthropogenic sources and a natural flow regime.

2 These objectives apply to the maximum extent allowed by law. To the extent that the State lacks jurisdiction, the Site Specific Dissolved Oxygen Objectives for the Mainstem Klamath River are extended as a recommendation to the applicable regulatory authority.

3 Corresponding DO concentrations are calculated as daily minima, based on ~~site~~ waterbody- specific barometric pressure, water-specific salinity, and natural receiving water temperatures as estimated by the T1BSR run of the Klamath TMDL model and described in Tetra Tech, December 23, 2009. Modeling Scenarios: Klamath River Model for TMDL Development. The estimates of natural receiving water temperatures used in these calculations may be updated as new data or method(s) become available. After opportunity for public comment, any update or improvements to the estimate of natural receiving water temperature must be reviewed and approved by Executive Officer before being used for this purpose.

TABLE 3-1b WATERBODY-SPECIFIC OBJECTIVES FOR TEMPERATURE IN THE UPPER TRINITY RIVER		
Location/River Reach	**Daily Average Not to Exceed**	**Time Period**
Lewiston Dam to Douglas City Bridge	60°F	July 1 – September 14
	56°F	September 15 – October 1
Lewiston Dam to confluence of North Fork Trinity River	56°F	October 1 - December 31

TABLE 3-2

INORGANIC, ORGANIC, AND FLUORIDE CONCENTRATIONS NOT TO BE EXCEEDED IN DOMESTIC OR MUNICIPAL SUPPLY [1, 2]

	LIMITING CONCENTRATION IN MILLIGRAMS PER LITER			
Constituent	**Lower**	**Optimum**	**Upper**	**Maximum Contaminant Level, mg/L**
Fluoride [3]				
53.7 and below	0.9	1.2	1.7	2.4
53.8 to 58.3	0.8	1.1	1.5	2.2
58.4 to 63.8	0.8	1.0	1.3	2.0
63.9 to 70.6	0.7	0.9	1.2	1.8
70.7 to 79.2	0.7	0.8	1.0	1.6
79.3 to 90.5	0.6	0.7	0.8	1.4
Inorganic Chemicals				
* Aluminum				1.0
Arsenic				0.05
Barium				1.0
Cadmium				0.01
Chromium			0.05	
Lead				0.05
Mercury				0.002
Nitrate-N (as NO_3)				45.
Selenium				0.01
Silver				0.05
Organic Chemicals				
(a) Chlorinated Hydrocarbons				
Endrin				0.0002
Lindane				0.004
Methoxychlor				0.1
Toxaphene				0.005
(b) Chlorophenoxys				
2,4-D				0.1
2,4,5-TP (Silvex)				0.01
(c) Synthetics				
Atrazine				0.003
Bentazon				0.018
Benzene				0.001
Carbon Tetrachloride				0.0005
Carbofuran				0.018
Chlordane				0.0001

~~TABLE 3-2 (CONTINUED)~~

~~INORGANIC, ORGANIC, AND FLUORIDE CONCENTRATIONS NOT TO BE EXCEEDED IN DOMESTIC OR MUNICIPAL SUPPLY [1, 2]~~

~~LIMITING CONCENTRATION IN MILLIGRAMS PER LITER~~

	Constituent	Maximum Contaminant Level, mg/L
	(c) Synthetics (cont'd.)	
	1,2-Dibromo-3-chloropropane	0.0002
	1,4-Dichlorobenzene	0.005
	1,1-Dichloroethane	0.005
	1,2-Dichloroethane	0.0005
	cis-1,2-Dichloroethylene	0.006
	trans-1,2-Dichloroethylene	0.01
	1,1-Dichloroethylene	0.006
	1,2-Dichloropropane	0.005
	1,3-Dichloropropene	0.0005
	Di(2-ethylhexyl)phthalate	0.004
*	Ethylbenzene	0.680
	Ethylene Dibromide	0.00002
	Glyphosate	0.7
	Heptachlor	0.00001
	Heptachlor epoxide	0.00001
	Molinate	0.02
	Monochlorobenzene	0.030
	Simazine	0.010
	1,1,2,2-Tetrachloroethane	0.001
	Tetrachloroethylene	0.005
*	Thiobencarb	0.07
	1,1,1-Trichloroethane	0.200
	1,1,2-Trichloroethane	0.032
	Trichloroethylene	0.005
	Trichlorofluoromethane	0.15
	1,1,2-Trichloro-1,2,2-Trifluoroethane	1.2
	Vinyl Chloride	0.0005
*	Xylenes [4]	1.750

~~[1] Values included in this table have been summarized from California Code of Regulations, Title 22, Division 4, Chapter 15, Article 4, Sections 64435 (Tables 2 and 3) and 64444.5 (Table 5).~~

~~[2] The values included in this table are maximum contaminant levels for the purposes of groundwater and surface water discharges and cleanup. Other water quality objectives (e.g., taste and odor thresholds or other secondary MCLs) and policies (e.g., State Water Board "Policy With Respect to Maintaining High Quality Waters in California") that are more stringent may apply.~~ **(Deleted text is being relocated)**

~~[3] Annual Average of Maximum Daily Air Temperature, °F Based on temperature data obtained for a minimum of five years. The average concentration of fluoride during any month, if added, shall not exceed the upper concentration. Naturally occurring fluoride concentration shall not exceed the maximum contaminant level.~~

~~[4] Maximum Contaminant Level is for either a single isomer or the sum of the isomers.~~

~~* Constituents marked with an * also have taste and odor thresholds that are more stringent than the MCL listed. Taste and odor thresholds have also been developed for other constituents not listed in this table.~~

~~**WATER QUALITY OBJECTIVES FOR GROUNDWATERS**~~ **Deleted text is being relocated)**

General Objectives

Tastes and Odors

Groundwaters shall not contain taste- or odor-producing substances in concentrations that cause nuisance or adversely affect beneficial uses.

Numeric water quality objectives have been developed by the State Department of Health Services and U.S. EPA. These numeric objectives, as well as those available in the technical literature, are incorporated into waste discharge requirements and cleanup and abatement orders as appropriate.

Bacteria

In groundwaters used for domestic or municipal supply (MUN), the median of the most probable number of coliform organisms over any 7-day period shall be less than 1.1 MPN/100 ml, less than 1 colony/100 ml, or absent (State Department of Health Services).

Radioactivity

Groundwaters used for domestic or municipal supply (MUN) shall not contain concentrations of radionuclides in excess of the limits specified in California Code of Regulations, Title 22, Division 4, Chapter 15, Article 5, Section 64443, Table 4 and listed in Table 3-2 of this Plan.

Chemical Constituents

Groundwaters used for domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the limits specified in California Code of Regulations, Title 22, Division 4, Chapter 15, Article 4, Section 64435 Tables 2 and 3, and Section 64444.5 (Table 5) and listed in Table 3-2 of this Plan.

Groundwaters used for agricultural supply (AGR) shall not contain concentrations of chemical constituents in amounts that adversely affect such beneficial use.

Numerical objectives for certain constituents for individual groundwaters are contained in Table 3-1. As part of the state's continuing planning process, data will be collected and numerical water quality objectives will be developed for those mineral and nutrient constituents where sufficient information is presently not available for the establishment of such objectives.

COMPLIANCE WITH WATER QUALITY OBJECTIVES **Deleted text is being relocated to Chapter 4 Implementation Plans)**

The Regional Water Board recognizes that immediate compliance with new effluent and/or receiving water NPDES permit limitations based on new, revised or newly interpreted water quality objectives or prohibitions adopted by the Regional Water Board or the State Water Resources Control Board, or with new, revised or newly interpreted water quality criteria promulgated by the U.S. Environmental Protection Agency (USEPA)[1], may not be technically and/or economically feasible[2] in all circumstances.

[1] New, revised, or newly interpreted water quality objectives, criteria, or prohibitions means: 1) objectives as defined in Section 13050(h) of Porter-Cologne; 2) criteria as promulgated by the USEPA; or 3) prohibitions as defined in the Water Quality Control Plan for the North Coast Region that are adopted, revised, or newly interpreted after November 29, 2006. Objectives and criteria may be narrative or numeric.

[2] Technical and economic feasibility shall be determined consistent with State Board Resolution No. 92-49.

Where the Regional Water Board determines that it is infeasible for an existing discharger[3] to immediately comply with NPDES permit effluent limitations or where appropriate, receiving water limitations, specified to implement

~~new, revised or newly interpreted water quality objectives, criteria or prohibitions; issuance of a schedule of compliance[4] may be appropriate.~~

~~Similarly, immediate compliance may not be technically and/or economically feasible for existing non-NPDES dischargers that, under new interpretation of law, are newly required to comply with new NPDES permitting requirements. Issuance of a schedule of compliance may be appropriate in these circumstances as well, to comply with effluent and/or receiving water limitations specified to implement objectives, criteria, or prohibitions that are adopted, revised, or reinterpreted after July 1, 1977, and that were not included in the non-NPDES permit.~~

~~Any schedule of compliance shall require achievement of the effluent limitations and/or receiving water limitations within the shortest feasible period of time, taking into account the factors identified in Chapter 4 for the implementation of schedules of compliance. All schedules of compliance will be limited to the time frames set out in Chapter 4.~~

~~[3] Existing discharger as defined in the State "Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California," (CTR-SIP) means: any discharger (non-NPDES or NPDES) that is not a new discharger. An existing discharger includes an increasing discharger (i.e., an existing facility, with treatment systems in place for its current discharge that is or will be expanding, upgrading, or modifying its existing permitted discharge after November 29, 2006). A new discharger includes any building, structure, facility, or installation from which there is, or may be, a discharge of pollutants, the construction of which commenced after November 29, 2006.~~

~~[4] Schedule of compliance: as defined in Section 502 (17) of the Clean Water Act, means: a schedule of remedial measures including an enforceable sequence of actions or operations leading to compliance with an effluent limitation, other limitation, prohibition, or standard.~~

Appendix B

This appendix contains the strikethrough/underline version of the proposed changes to Section 4 - Implementation Plans.

Notes to Readers:

1) *The following provides existing and new language for Chapter 4 - Implementation Plans (Implementation Policies and Action Plans). Revisions to the Chapter are shown in strikethrough and underline format. Proposed deletions to the original Basin Plan language are shown in ~~strikethrough~~. Proposed additions are indicated by underlining. Formatting changes, such as deletion of extra spaces, reformatting of paragraphs and tables, additions of bullets, etc., are not necessarily reflected in strikethough/underline format.*

2) This update proposes to rename sections of the Basin Plan to chapters.

4. IMPLEMENTATION POLICIES AND ACTION PLANS

4.1 INTRODUCTION

This ~~section~~ chapter presents the policies and action~~s~~ plans designed ~~intended~~ to achieve ~~meet~~ water quality objectives and protect beneficial uses of waters of the state in the ~~Klamath River Basin and~~ North Coast~~al Basin~~ Region. ~~The following m~~Measures shall be taken to restore, maintain, and protect ambient water quality conditions from ~~with respect to~~ actual and potential point and nonpoint sources of water quality degradation~~.~~ and other controllable factors.

Actions to achieve water quality objectives and support beneficial uses will require the coordinated efforts of the Regional Water Board, other agencies, non-governmental organizations, and regulated entities. An implementation program is an integral part of the Basin Plan. The implementation program is required to include, at a minimum, the following components:

- A description of the nature of the actions that are necessary to achieve the objectives, including recommendations for appropriate action by any entity, public or private
- A time schedule for the actions to be taken
- A description of surveillance to be undertaken to determine compliance with the objectives[1].

4.2 CONTROLLABLE WATER QUALITY FACTORS

Controllable water quality factors shall conform to the water quality objectives ~~contained herein~~ in this Basin Plan. When other factors result in the degradation of water quality beyond the levels or limits established as water quality objectives, controllable factors shall not cause further degradation of water quality. Controllable water quality factors are those actions, conditions, or circumstances resulting from ~~man's~~ human activities that may influence the quality of the waters of the state and that may be reasonably controlled. **Relocated & Revised Text from Chapter 3)**

4.3 CONTROL ACTIONS

This section is intended to generally describe the authorities of the State Water Board, the Regional Water Board and other agencies with respect to water quality control.

4.3.1 Control Actions under State Water Board Authority

The State Water Resources Control Board (State Water Board) has adopted several statewide or area wide water quality plans and policies that complement or may supercede portions of this Basin Plan. These plans and policies may include water quality standards, implementation or control measures, water rights or monitoring requirements. See the State Water Board Website, "Plans and Policies," for the full range of plans and policies adopted by the State Water Board.

4.3.2 Control Actions to be Implemented by Other Agencies with Water Quality or Related Authority

Water quality management plans prepared under Section 208 of the Federal Water Pollution Control Act (Clean Water Act) have been completed by various public agencies. These Section 208 plans, as well as other plans adopted by federal, state, and local agencies, may affect the Regional Water Board's water quality management and control activities. The Regional Water Board can also be party to official

[1] Wat. Code § 13242

agreements with other agencies, such as memoranda of understanding (MOUs) or management agency agreements (MAAs) that recognize and rely on the water quality authority of other agencies.

4.3.3 Control Actions under Regional Water Board Authority

A program of implementation by the Regional Water Board must provide for the attainment of this Basin Plan's water quality standards (see Chapter 2, "Beneficial Uses," and Chapter 3, "Water Quality Objectives," and "Antidegradation Policies"), as well as any relevant water quality standards adopted by the State Water Board.

One of the primary ways in which the Regional Water Board regulates controllable water quality factors associated with discharges is through permits, orders, and other actions imposing waste discharge limitations on specific and general categories of discharges and potential discharges. Water quality objectives form the basis for the permits, orders and other actions that are pursuant to the Regional Water Board's authority. These permits, orders, and other actions include, but are not limited to waste discharge requirements (including provisions required by federal law), waivers of waste discharge requirements, total maximum daily loads, water quality certifications, waste discharge prohibitions, and maximum acceptable cleanup levels.

4.3.4 Water Quality Certification

Under the Clean Water Act Section (CWA) 401 Water Quality Certification (Water Quality Certification), the Regional Water Board has broad authority to review proposed activities that require federal permits in and/or affecting "waters of the United States (U.S.)" within the Region. A Water Quality Certification is an order certifying that the proposed project will comply with CWA Sections 301 (Effluent Limitation), 302 (Water Quality Related Effluent Limitations), 303 (Water Quality Standards and Implementation Plans), 306 (National Standards of Performance) and 307 (Toxic Pretreatment Effluent Standards); will comply with applicable state laws; and, will be protective of beneficial uses identified within the Basin Plan. The Regional Water Board can then grant, condition, or deny certification of federal permits or licenses that may result in a discharge to waters of the U.S.

The Regional Water Board will refer to the following for guidance when permitting or otherwise acting on dredge or fill projects:

- Governor's Executive Order W-59-93 (signed August 23, 1993; also known as the California Wetlands Conservation Policy);
- Senate Concurrent Resolution No. 28;
- Water Codes section 13142.5 (applies to coastal marine wetlands).

The goals of the California Wetlands Conservation Policy include ensuring "no overall net loss," achieving a "long-term net gain in the quantity, quality, and permanence of wetlands acreage and value…", and reducing "procedural complexity in the administration of state and federal wetlands conservation programs."

Senate Concurrent Resolution No. 28 states, "It is the intent of the legislature to preserve, protect, restore, and enhance California's wetlands and the multiple resources which depend on them for the benefit of the people of the state."

Water Code section 13142.5 states, "Highest priority shall be given to improving or eliminating discharges that adversely affect…wetlands, estuaries, and other biological sensitive sites."

4.3.5 National Pollutant Discharge Elimination System (NPDES)

NPDES permits are issued to regulate point source discharges of waste to "waters of the U.S." including discharges of storm water from municipal separate storm sewer systems and certain categories of industrial activity. Waters of the U.S. are surface waters such as rivers, lakes, bays, estuaries, oceans, etc. The issuance of NPDES permits is authorized by Section 402 of the Clean Water Act and Section 13370 of the Water Code. The permit content and the issuance process are contained in the Code of Federal Regulations (40 CFR Part 122) and Title 23, Chapter 9 of the California Code of Regulations, respectively. The U.S. Environmental Protection Agency (USEPA) has approved the state's program to regulate point source discharges of waste, including storm water, to waters of the U.S. The state, through the State and Regional Water Boards, issues the NPDES permits, reviews discharger self-monitoring reports, performs independent compliance checking, and takes enforcement actions as needed.

NPDES permits also require publicly owned treatment works to conduct pretreatment programs if their design capacity is greater than 5 million gallons per day. Smaller publicly owned treatment works may be required to conduct pretreatment programs if there are significant industrial users of their systems. The pretreatment programs must comply with the federal regulations at 40 CFR Part 403.

4.3.6 Waste Discharge Requirements (WDRs)

Waste Discharge Requirements (WDRs) are necessary for any persons discharging or proposing to discharge waste that could affect the quality of the waters of the state[2]. The Regional Water Board reviews the nature of the proposed discharge and adopts WDRs to protect the beneficial uses of waters of the state and to implement the Antidegradation Policy. Waste discharge requirements could be adopted as individual permits (e.g., for a particular facility), group permits (e.g., for facilities within a particular watershed), or general permits (e.g., for facilities conducting a particular activity) in accordance with Section 13263 of the Water Code. The Water Code authorizes Regional Water Boards to regulate discharges of waste to land to protect water quality by issuing WDRs. Regional Water Boards review self-monitoring reports submitted by the discharger, perform independent compliance checking, take enforcement actions as needed, and periodically review and update WDRs.

4.3.7 Waivers of WDRs

Regional Water Boards may conditionally waive WDRs if the Regional Water Board determines that such conditional waiver is in the public interest[3]. The requirement to submit a Report of Waste Discharge can also be waived. A conditional Waiver of WDRs may not exceed five years, and may be terminated at any time by the Regional Water Board. A Waiver of WDRs could be adopted as individual permits (e.g., for a particular facility), group permits (e.g., for facilities within a particular watershed), or general waiver (e.g., for facilities conducting a particular activity) in accordance with Section 13269 of the Water Code. Regional Water Boards issue Waivers of WDRs, review self-monitoring reports submitted by the discharger, perform independent compliance checking, and take enforcement actions as needed.

4.4 PROHIBITIONS AND EXCEPTIONS TO PROHIBITIONS

The Regional Water Board can prohibit specific types of discharges to certain areas[4]. These discharge prohibitions may be revised, rescinded, or adopted, as necessary. Discharge prohibitions are described in the “Waste Discharge Prohibitions” section of this Chapter. For certain circumstances, the Regional Water Board will allow exceptions to some of these prohibitions. Prohibition exceptions are further described in the “Waste Discharge Prohibitions” section of this Chapter.

4.5 MONITORING AND REPORTING

Monitoring and reporting programs are specified in the permits, orders, and other regulatory actions of the Regional Water Board or may be issued separately. Monitoring and reporting includes, but is not limited

[2] Wat. Code § 13260
[3] Wat. Code § 13269
[4] Wat. Code § 13243

to, a description of the sampling and analytical methods, monitoring locations, and monitoring and reporting schedule necessary to determine compliance with the provisions of the permit, order, or other regulatory action, or the requirements of the Basin Plan. Where appropriate, the *Standard Methods for the Examination of Water and Wastewater,* latest edition (American Public Health Association, et al.) generally applies.

4.6 COMPLIANCE WITH WATER QUALITY OBJECTIVES

It is not feasible to establish direction on compliance with water quality standards as appropriate for all circumstances and conditions which could be created by all discharges. Therefore, it is within the discretion of the Regional Water Board to establish direction on compliance with applicable water quality standards within individual or general permits, orders and other regulatory actions. Whenever the Regional Water Board finds that a discharge of waste violates or will violate requirements prescribed by the Regional Water Board or by the State Water Board, or waste treatment and/or disposal facilities are approaching capacity, the Regional Water Board may approve a time schedule of specific actions to correct and/or prevent a violation of requirements[5]. The Regional Water Board recognizes that immediate compliance with new effluent and/or receiving water NPDES permit limitations based on new, revised or newly interpreted water quality objectives or prohibitions adopted by the Regional Water Board or the State Water Board, or with new, revised or newly interpreted water quality criteria promulgated by the U.S. Environmental Protection Agency (USEPA)[6], may not be technically and/or economically feasible[7] in all circumstances. **Relocated text from Chapter 3)** In such cases, the Regional Water Board may issue a time schedule order, as appropriate. Any schedule of compliance shall require achievement of the effluent limitations and/or receiving water limitations within the shortest feasible period of time. **Relocated Text from Chapter 3)** The issuance of an NPDES permit containing a compliance schedule will be in accordance with the State Water Board *Policy for Compliance Schedules in NPDES Permits*[8] and will result in discharge compliance with applicable requirements of the Clean Water Act.

4.7 ENFORCEMENT ACTIONS

The State Water Board has adopted the Water Quality Enforcement Policy to provide guidance that will enable Regional Water Board staff to expend its limited resources in ways that openly address the greatest needs, deter harmful conduct, protect the public, and achieve maximum water quality benefits. The Enforcement Policy articulates expectations and priorities for the State Water Board and nine Regional Water Boards. The Enforcement Policy includes several sections outlining consistent guidance to the Regional Water Boards that include: 1) Fair, Firm and Consistent Enforcement; 2) Enforcement Priorities for Discretionary Enforcement Actions; 3) Enforcement Actions; 4) State Water Board Enforcement Actions; 5) Coordination with Other Regulatory Agencies; 6) Monetary Assessment in Administrative Civil Liability (ACL) Actions; 7) Mandatory Minimum Penalties for NPDES Violations; 8) Compliance Projects; 9) Enhanced Compliance Actions; 10) Discharge Violation Reporting; 11) Violation and Enforcement Data; 12) Enforcement Reporting; and 13) Policy Review and Revision.

The Enforcement Policy outlines the various measures (formal and informal) to provide a consistent approach throughout the state. These measures can include the following types of actions.

[5] Wat. Code § 13300
[6] New, revised, or newly interpreted water quality objectives, criteria, or prohibitions means: 1) objectives as defined in Section 13050(h) of Porter-Cologne; 2) criteria as promulgated by the USEPA; or 3) prohibitions as defined in the Water Quality Control Plan for the North Coast Region that are adopted, revised, or newly interpreted after November 29, 2006. Objectives and criteria may be narrative or numeric.
[7] Technical and economic feasibility shall be determined consistent with State Board Resolution No. 92-49.
[8] State Water Board Resolution No. 2008-0025.

4.7.1 Informal Enforcement Actions

An informal enforcement action is any enforcement action taken by Regional Water Board staff that is not defined in statute or regulation. Informal enforcement action can include any form of communication (oral, written, or electronic) between Regional Water Board staff and a discharger concerning an actual, threatened, or potential violation. Informal enforcement actions cannot be petitioned to the State Water Board. Informal enforcement actions may include:

4.7.1.1. Oral and Written Contact

For many violations, the first step is an oral contact. This involves contacting the discharger by phone or in person and informing the discharger of the specific violations, discussing how and why the violations have occurred or may occur, and discussing how and when the discharger will correct the violation and achieve compliance.

4.7.1.2 Notice of Violation

A notice of violation or NOV is a letter formally advising a discharger in noncompliance that additional enforcement actions may be necessary if appropriate corrective actions are not taken. The NOV letter is the most significant level of informal enforcement action and should be used only where a violation has actually occurred. The NOV letter shall include a description of specific violation, a summary of potential enforcement options available to address noncompliance (including potential ACL assessments), and a request for a certified, written response by a specified date that either confirms the correction of the violation or identifies a date by which the violation will be corrected. The NOV can be combined with a request for technical information pursuant to Water Code section 13267.

4.7.2 Formal Enforcement Actions

Formal enforcement actions are statutorily based actions to address a violation or threatened violation of water quality laws, regulations, policies, plans, or orders. The actions listed below present options available for enforcement.

4.7.2.1 Notices to Comply

A Notice to Comply (Notice) can be issued for minor violations during field inspections by Regional Water Board staff, at the discretion of the inspector. Water Code section 13399 *et seq*. deals with statutorily defined “minor” violations. A violation is determined to be “minor” by the State Water Board or the Regional Water Board after considering factors defined in Water Code section 13399, subdivisions (e) and (f), and the danger the violation poses to, or the potential that the violation presents for endangering human health, safety, welfare, or the environment.

4.7.2.2 Notices of Stormwater Noncompliance

The Stormwater Enforcement Act of 1998 (Water Code section 13399.25 et seq.) requires that each Regional Water Board provide a notice of noncompliance to any stormwater dischargers who have failed to file a notice of intent to obtain coverage, a notice of non-applicability, a construction certification, or annual reports. If, after two notices, the discharger fails to file the applicable document, the Regional Water Board shall issue a complaint for administrative civil liability against the discharger. Alternatively, the Water Boards may enforce most of these violations under Water Code section 13385.

4.7.2.3 Technical Reports and Investigations

Water Code sections 13267, subdivision (b), and 13383 allow the Regional Water Board to conduct investigations and to require technical or monitoring reports from any person who has discharged, discharges, or is suspected of having discharged, or who proposes to discharge waste in accordance with the conditions in the section. When requiring reports pursuant to Water Code section 13267, subdivision (b), the Regional Water Board must ensure that the burden, including costs of the reports, bears a reasonable relationship to the need for the reports and the benefits to be obtained from them. Further, the Regional Water Board shall provide a written explanation with regard to the need for the reports and identify the evidence that supports requiring them.

4.7.2.4 Cleanup and Abatement Orders

Cleanup and Abatement Orders (CAOs) are adopted pursuant to Water Code section 13304. CAOs may be issued to any person who has discharged or discharges waste into the waters of this state in violation of any waste discharge requirement or other order or prohibition issued by a Regional Water Board or the State Water Board, or who has caused or permitted, causes or permits, or threatens to cause or permit any waste to be discharged or deposited where it is, or probably will be, discharged into the waters of the state and creates, or threatens to create, a condition of pollution or nuisance (discharger). The CAO requires the discharger to clean up the waste or abate the effects of the waste, or both, or, in the case of threatened pollution or nuisance, take other necessary remedial action, including, but not limited to, overseeing cleanup and abatement efforts.

4.7.2.5 Section 13300 Time Schedule Orders

Pursuant to Water Code section 13300, a Regional Water Board can require the discharger to submit a time schedule that sets forth the actions the discharger will take to address actual or threatened discharges of waste in violation of requirements. Typically, those schedules, after any appropriate adjustments by the Regional Water Board, are then memorialized in an order. Time Schedule Orders (TSOs) that require submission of technical and monitoring reports should state that the reports are required pursuant to Water Code section 13267.

4.7.2.6 Section 13308 Time Schedule Orders

Water Code section 13308 authorizes the Regional Water Board to issue a Time Schedule Order (13308 TSO) that prescribes, in advance, a civil penalty if compliance is not achieved in accordance with the time schedule. The Regional Water Board may issue a 13308 TSO if there is a threatened or continuing violation of a cleanup and abatement order, cease and desist order, or any requirement issued under Water Code sections 13267 or 13383. The penalty must be set based on an amount reasonably necessary to achieve compliance and may not contain any amount intended to punish or redress previous violations. The 13308 TSO provides the Regional Water Boards with their primary mechanism for motivating compliance, and if necessary, assessing monetary penalties against federal facilities. Orders under this section are an important tool for regulating federal facilities. If the discharger fails to comply with the 13308 TSO, the discharger is subject to a complaint for Administrative Civil Liability. The State Water Board may issue a 13308 TSO if the violation or threatened violation involves requirements prescribed by a State Water Board Order.

4.7.2.7 Cease and Desist Orders

Cease and Desist Orders (CDOs) are adopted pursuant to Water Code sections 13301 and 13303. CDOs may be issued to dischargers violating or threatening to violate WDRs or prohibitions prescribed by the Regional Water Board or the State Water Board. Section 4477 of the California Government Code prohibits all state agencies from entering into contracts of $5,000 or more for the purchase of supplies, equipment, or services from any nongovernmental entity who is the subject of a CDO that is no longer under review and that was issued for violation of WDRs or which has been finally determined to be in violation of federal laws relating to air or water pollution.

4.7.2.8 Modification or Rescission of WDRs

In accordance with the provisions of the Water Code, a Regional Water Board may modify or rescind WDRs in response to violations. Depending on the circumstances of the case, rescission of WDRs may be appropriate for failure to pay fees, penalties, or liabilities; a discharge that adversely affects beneficial uses of the waters of the state; and violation of the State Water Board General WDRs for discharge of bio-solids due to violation of the Background Cumulative Adjusted Loading Rate. Rescission of WDRs generally is not an appropriate enforcement response where the discharger is unable to prevent the discharge, as in the case of a POTW.

4.7.2.9 Administrative Civil Liabilities

Administrative Civil Liabilities (ACLs) are monetary liabilities imposed by a Regional Water Board or the State Water Board. The Water Code authorizes the imposition of an ACL for certain violations of law. The factors used to assess the appropriate penalties are addressed in Section VI of the Enforcement Policy. It is the policy of the State Water Board that a 30 day public comment period shall be posted on the Regional Water Board website prior to the settlement or imposition of any ACL, including mandatory minimum penalties, and prior to settlement of any judicial civil liabilities. In addition, for civil liabilities that are expected to generate significant public interest, the Regional Water Board may consider mailing or e-mailing the notice to known interested parties, or publishing the notice in a local newspaper.

POINT SOURCE MEASURES

Waste Discharge Prohibitions
This section has not been modified and is relocated after section 4.7.

Klamath River Basin
This section has not been modified.

North Coast Basin
This section has not been modified.

~~SCHEDULES OF COMPLIANCE~~

~~The Regional Water Board may establish a Schedule of Compliance in an National Pollution Discharge Elimination System (NPDES) permit under the following circumstances:~~[3,4]

1) ~~Where an existing discharger[5] has demonstrated, to the Regional Water Board's satisfaction, that it is infeasible to achieve immediate compliance with effluent and/or receiving water limitations specified to implement new, revised, or newly interpreted water quality objectives, criteria, or prohibitions[6].~~

2) ~~Where a discharger is required to comply with Total Maximum Daily Loads (TMDLs) adopted as a single permitting action,[7] and demonstrates that it is infeasible to achieve immediate compliance with effluent and/or receiving water limits that are specified to implement new, revised or newly interpreted objectives, criteria, or prohibitions.~~

~~The schedule of compliance shall include a time schedule for completing specific actions (including interim effluent limits) that demonstrate reasonable progress toward attaining the effluent and/or receiving water limitations, water quality objectives, criteria, or prohibitions. The schedule of compliance shall contain interim limits and a final compliance date based on the shortest feasible time required to achieve compliance (determined by the Regional Water Board at a public hearing after considering the factors identified below).~~

Schedules of compliance in NPDES permits for existing NPDES permittees shall be as short as feasible, but in no case exceed the following:

- Up to five years from the date of permit issuance, re-issuance, or modification that establishes effluent and/or receiving water limitations specified to implement new, revised, or newly interpreted objectives, criteria, or prohibitions. A permittee can apply for up to a five-year extension, but only where the conditions of the schedule of compliance have been fully met, and sufficient progress toward achieving the objectives, criteria, or prohibitions has been documented.

- In no case shall a schedule of compliance for these dischargers exceed ten years from the effective date of the initial permit that established effluent and/or receiving water limitations specified to implement new, revised, or newly interpreted objectives, criteria, or prohibitions.

TMDL-derived effluent and/or receiving water limitations that are specified to implement new, revised, or newly interpreted water quality objectives, criteria, or prohibitions that are adopted as a single permitting action:

- In this scenario, schedules of compliance shall require compliance in the shortest feasible period of time, but may extend beyond ten years from the date of the permit issuance.

To document the need for and justify the duration of any such schedule of compliance, a discharger must submit the following information, at a minimum. The Regional Water Board will review the information submitted to determine if a schedule of compliance is appropriate.

For all applicants:

- A written request, and demonstration, with supporting data and analysis, that it is technically and/or economically infeasible[8] to achieve immediate compliance with newly adopted, revised or newly interpreted water quality objectives, criteria or prohibitions.
- Results of diligent efforts to quantify pollutant levels in the discharge and the sources of the pollutant in the waste stream
- Documentation of source control efforts currently underway or completed, including compliance with any pollution prevention programs that have been established.
- A proposed schedule for additional source control measures or waste treatment.
- The highest discharge quality that is technically and economically feasible to achieve until final compliance is attained.
- A demonstration that the proposed schedule of compliance is as short as technically and economically feasible.
- Data demonstrating current treatment facility performance to compare against existing permit effluent limits, as necessary to determine which is the more stringent interim limit to apply if a schedule of compliance is granted.
- Additional information and analyses, to be determined by the Regional Water Board on a case-by-case basis.

[3] Schedules of compliance for CTR criteria are independently authorized and governed by 40 CFR 122.47 and 131.38, and the State "Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California" (CTR-SIP). This amendment is intended to supplement, not supercede, these provisions required by the CTR-SIP. All CTR limits must be consistent with the CTR-SIP and applicable federal rules.

[4] Schedules of compliance for Non-NPDES Waste Discharge Requirements (WDRs) are also independently authorized by Porter Cologne, and will continue to be adopted on a case-by-case basis.

[5] Existing discharger is defined in the State "Policy for Implementation of Toxic Substance Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California," (CTR-SIP) as any discharger (non-NPDES or NPDES) that is not a new discharger.

~~An existing discharger includes an increasing discharger (i.e., an existing facility with treatment systems in place for its current discharge that is or will be expanding, upgrading, or modifying its existing permitted discharge after November 29, 2006). A new discharger includes any building, structure, facility, or installation from which there is, or may be, a discharge of pollutants, the construction of which commenced after November 29, 2006.~~

~~[6] New, revised, or newly interpreted water quality objectives, criteria, or prohibitions means: 1) objectives as defined in Section 13050(h) of Porter-Cologne; 2) criteria as promulgated by the United States Environmental Protection Agency (USEPA); or 3) prohibitions as defined in the *Water Quality Control Plan for the North Coast Region* that are adopted, revised, or newly interpreted after November 29, 2006. Objectives and criteria may be narrative or numeric.~~

~~[7] "Single permitting actions" means those where the Regional Board incorporates the requirements to implement a TMDL through one NPDES permit. These actions would not require a Basin Plan amendment, but would require a technical staff report to support the permit requirements and any permit specified compliance schedule. Furthermore, the USEPA would still be required to approve the TMDL under the federal CWA Section 303(d).~~

~~[8] Technial and economic feasibility shall be determined consistent with State Baord Order 92-49.~~

Appendix C

This appendix contains the clean copy version of the proposed changes to Chapter 3 - Water Quality Objectives.

3. WATER QUALITY OBJECTIVES

3.1 INTRODUCTION

The Regional Water Quality Control Board (Regional Water Board) is responsible for establishing water quality objectives (objectives) which, in the Regional Water Board's judgment, are necessary for the reasonable protection of beneficial uses of water (beneficial uses) and for the prevention of nuisance.[1] The beneficial uses of waters in the North Coast Region are described in Chapter 2 and include uses associated with aquatic life, ecological functioning, and human health and welfare. Existing and potential beneficial uses are designated for individual waterbodies in Table 2-1. The federal Antidegradation Policy requires that existing water uses and the level of water quality necessary to protect those uses be maintained and protected[2]. Existing uses are those uses of the waterbody that are attained on or after November 28, 1975, whether or not they are designated in this Basin Plan[3]. Nuisance is defined to mean anything which meets all of the following requirements:

1. Is injurious to health, or is indecent or offensive to the senses, or an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life or property.
2. Affects at the same time an entire community or neighborhood, or any considerable number of persons, although the extent of the annoyance or damage inflicted upon individuals may be unequal.
3. Occurs during, or as a result of, the treatment or disposal of wastes.[4]

3.1.1 Water Quality Objectives

The quality of water is defined by the chemical, physical, biological, bacteriological, radiological, and other properties and characteristics of water which affect its use.[5] There are two types of objectives: narrative and numeric. Narrative objectives present general descriptions of water quality that must be attained through pollutant control measures, watershed management, and restoration actions. They also serve as the basis for the development of detailed numeric objectives. Narrative and numeric water quality objectives define the upper concentration or other limits that the Regional Board considers protective of beneficial uses. The general methodology used in establishing water quality objectives involves, first, designating beneficial water uses; and second, selecting and quantifying the water quality parameters necessary to protect the most vulnerable (sensitive) beneficial uses. Water quality objectives are established to protect beneficial uses and the existing high quality waters of the state. The Regional Water Board may apply more stringent criteria to maintain high-quality waters, as per the state Antidegradation Policy (see below).

It is within the discretion of the Regional Water Board to establish other, or additional, direction on protection of beneficial uses and compliance with objectives of this Basin Plan. To evaluate compliance with water quality objectives, the Regional Water Board will consider all relevant and scientifically valid evidence, including relevant and scientifically valid numeric criteria and guidelines developed and/or published by other agencies and organizations. Generally, numeric values are derived from relevant state or federal laws, regulations, plans, or policies; numeric water quality criteria, standards, or guidelines developed and published by governmental and non-governmental agencies and organizations; and relevant peer-reviewed scientific literature.

Established governmental and non-governmental agencies and organizations include, but are not limited to: California State Water Resources Control Board, California Department of Public Health, California Office of Environmental Health Hazard Assessment, California Department of Toxic Substances Control,

[1] Wat. Code § 13241
[2] 40 CFR § 131.12(a)(1)
[3] 40 CFR § 131.3(e)
[4] Wat. Code § 13050(m)
[5] Wat. Code § 13050(g)

University of California Cooperative Extension, California Department of Fish and Wildlife, U.S. Environmental Protection Agency, U.S. Food and Drug Administration, National Academy of Sciences, U.S. Fish and Wildlife Service, the Food and Agricultural Organization of the United Nations and the World Health Organization. The State Water Board has compiled numeric water quality values from the literature for over 860 chemical constituents in a document entitled *A Compilation of Water Quality Goals*. A searchable *Water Quality Goals* database is accessible on the State Water Board website. The Regional Water Board has compiled water quality values from the literature for sediment-related indices and published them in a peer-reviewed report entitled *Desired Salmonid Freshwater Habitat Conditions for Sediment-Related Indices* (July 2006). This document can be found on the Regional Water Board website. On a case by case basis, the Regional Water Board may collect or request that a discharger collect site specific data or conduct site specific water quality assessments or studies for the purpose of translating the applicable narrative objective into a site specific numeric threshold or thresholds.

The water quality objectives contained herein once adopted by the Regional Water Board are applicable to several classes of water (see Chapter 2 for a description of classes of water). Other water quality objectives [e.g., taste and odor thresholds or other secondary Maximum Contaminant Levels (MCLs)] and policies (e.g., State Water Board *Policies and Procedures for Investigation and Cleanup and Abatement of Discharges Under Water Code Section* 13304) may apply and may be more stringent. Where more than one objective exists for the same water quality parameter, the objective protective of the most sensitive beneficial use applies. The State Water Board's *Policy With Respect to Maintaining High Quality Waters in California* commonly referred to as the state Antidegradation Policy applies to all classes of water. The state policy incorporates the federal Antidegradation Policy, where the federal Antidegradation Policy is applicable.

The State Water Board also adopts water quality control plans for application statewide. Water quality control plans adopted by the State Water Board are applicable in the North Coast Region independent of the Basin Plan and supercede duplicative requirements established in the Basin Plan. The Enclosed Bays and Estuaries Plan, the Ocean Plan, and the Thermal Plan are examples of water quality control plans adopted by the State Water Resources Control Board (see the State Water Board website).

The Regional Water Board reviews the Basin Plan including the water quality objectives every three years during the Triennial Review period to evaluate the need for appropriate modification. The Triennial Review process is described in the Introduction to the Basin Plan (Chapter 1). As part of the state's continuing planning process, data is collected and numeric water quality objectives developed where sufficient information is presently not available for the establishment of such objectives.

3.1.2 Water Quality Standards

The federal Clean Water Act defines "water quality standards" to include "designated uses" (i.e., beneficial uses), "water quality criteria" (i.e., water quality objectives), and an antidegradation policy. The beneficial uses in Chapter 2 of this Basin Plan, the water quality objectives contained in this Chapter, and the *Statement of Policy with Respect to Maintaining High Quality Waters in California*, as described below, are this region's water quality standards for purposes of the Clean Water Act.

3.1.3 Water Quality Objectives and Effluent Limitations

It is important to recognize the distinction between ambient water quality objectives and "effluent limitations" or "discharge standards", which are conditions in state and federal waste discharge requirements. Effluent limitations are established in permits both to protect water for beneficial uses within the area of the discharge, and to meet or achieve water quality objectives. Compliance with water quality objectives is further detailed in Chapter 4 (Implementation Plans).

3.2 ANTIDEGRADATION POLICIES

The following policies shall apply to all waters of the Region, or as described.

Whenever the existing quality of water is better than that established by water quality objectives, such existing water quality shall be maintained unless otherwise provided by the provisions of State Water Board Resolution No. 68-16, *Statement of Policy with Respect to Maintaining High Quality of Waters in California* (state Antidegradation Policy), including any revisions thereto. The State Water Board has interpreted the state Antidegradation Policy to incorporate the federal Antidegradation Policy where the federal policy applies (State Board Order WQO 86-17). The state Antidegradation Policy can be found at the State Water Board's website. The federal Antidegradation Policy is found at 40 CFR Section 131.12. The state and federal antidegradation policies are implemented independent of this Basin Plan provision. A summary of the state and federal antidegradation policies is provided here for the convenience of the reader.

The state Antidegradation Policy applies more comprehensively to water quality changes than the federal policy. In particular, the state Antidegradation Policy applies to those groundwaters and surface waters in which the existing water quality meets or exceeds (is better than) water quality objectives. Such groundwaters and surface waters are defined as high quality waters. The state Antidegradation Policy establishes two conditions that must be met before the quality of high quality waters may be lowered by nonpoint or point source waste discharges, whether or not such a discharge is allowed under a new, renewed, or revised permit.

First, the state must determine that lowering the quality of high quality waters:

- Will be consistent with the maximum benefit to the people of the state,
- Will not unreasonably affect present and anticipated beneficial uses of such water, and
- Will not result in water quality less than that prescribed in state policies (e.g., water quality objectives in water quality control plans).

Second, any activities that result in discharges to high quality waters are required to:

- Meet waste discharge requirements that will result in the best practicable treatment or control of the discharge necessary to avoid pollution or nuisance and
- Maintain the highest water quality consistent with the maximum benefit to the people of the state.

If such treatment or control results in a discharge that maintains the existing high water quality, then a less stringent level of treatment or control would not be in compliance with the state Antidegradation Policy.

Likewise, a discharge to high quality water could not be allowed under the state Antidegradation Policy if the discharge, even after treatment or control, would unreasonably affect beneficial uses or would not comply with applicable provisions of water quality control plans.

The federal Antidegradation Policy applies to surface waters regardless of the level of existing water quality. Where water quality is better than the minimum necessary to support existing or anticipated beneficial uses of surface water, the federal Antidegradation Policy requires that quality to be maintained and protected, unless the state finds, after ensuring public participation, that:

- Such activity is necessary to accommodate important economic or social development in the area in which the waters are located~~,~~;

- Water quality is adequate to protect existing beneficial uses fully; and,

- The highest statutory and regulatory requirements for all new and existing point source discharges and all cost-effective and reasonable best management practices for nonpoint source control are achieved.

Under the federal Antidegradation Policy, an activity that results in discharge to surface water would be prohibited if the discharge would lower the quality of surface waters that do not currently attain water quality standards. Both the state and federal antidegradation policies acknowledge that an activity that results in a minor water quality lowering, even if incrementally small, can result in a violation of antidegradation policies through cumulative effects, especially, for example, when the waste discharge contains a cumulative, persistent, or bioaccumulative pollutant or pollutants.

3.3 WATER QUALITY OBJECTIVES FOR OCEAN WATERS

The provisions of the State Water Board *Water Quality Control Plan for Ocean Waters of California* (Ocean Plan) and *Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California* (Thermal Plan) and any revisions thereto shall apply to ocean waters within the North Coast Region. These plans can be found at the State Water Board website.

3.4 WATER QUALITY OBJECTIVES FOR INLAND SURFACE WATERS, ENCLOSED BAYS, AND ESTUARIES

Federal water quality criteria contained in the National Toxics Rule[6] (NTR) and the California Toxics Rule[7] (CTR) and any revisions thereto address human health and aquatic life protection and shall apply to inland surface waters, enclosed bays, and estuaries of the North Coast Region. NTR and CTR water quality criteria are implemented through the provisions of the State Water Board's *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (SIP). This policy can be found at the State Water Board website. These provisions are incorporated by reference into this Basin Plan. This incorporation by reference is prospective, including future changes to the incorporated provisions as the changes take effect.

In addition to, the Antidegradation Policy, the waterbody-specific objectives contained in Tables 3-1, 3-1a, and 3-1b, and the following objectives shall apply to inland surface waters, enclosed bays, and estuaries of the North Coast Region. The water quality objectives are presented below.

3.4.1 Bacteria

The bacteriological quality of waters of the North Coast Region shall not be degraded beyond natural background levels. In no case shall coliform concentrations in waters of the North Coast Region exceed the following:

In waters designated for contact recreation (REC-1), the median fecal coliform concentration based on a minimum of not less than five samples for any 30-day period shall not exceed 50/100 ml, nor shall more than ten percent of total samples during any 30-day period exceed 400/100 ml (State Water Board Division of Drinking Water).

[6] 40 C.F.R. § 131.36.
[7] 40 C.F.R. § 131.38.

At all areas where shellfish may be harvested for human consumption (SHELL), the fecal coliform concentration throughout the water column shall not exceed 43/100 ml for a 5-tube decimal dilution test or 49/100 ml when a three-tube decimal dilution test is used (National Shellfish Sanitation Program, *Manual of Operation*).

3.4.2 Biostimulatory Substances

Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.

3.4.3 Chemical Constituents

In no case shall waters contain concentrations of chemical constituents in amounts that cause nuisance or adversely affect beneficial uses.

Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the following maximum contaminant level (MCL) and secondary maximum contaminant level (SMCL) provisions specified in Title 22 of the California Code of Regulations:

- Table 64431-A, MCLs - Inorganic Chemicals (§ 64431)
- Table 64444-A, MCLs - Organic Chemicals (§ 64444)
- Table 64449-A, SMCLs - "Consumer Acceptance Contaminant Levels" (§ 64449)
- Table 64449-B, SMCLs - "Consumer Acceptance Contaminant Level Ranges" (§ 64449)
- Table 64442, Radionuclide Maximum Containment Levels and Detection Levels for Purposes of Reporting (DLRs) (§ 64442)
- Table 64443, Radionuclide Maximum Contaminant Levels and
- DLRs (§ 64443)

These provisions are incorporated by reference into this Basin Plan. This incorporation by reference is prospective, including future changes to the incorporated provisions as the changes take effect.

Numeric water quality objectives for individual waters are contained in Table 3-1, 3-1a, and 3-1b.

3.4.4 Color

Waters shall be free of coloration that causes nuisance or adversely affects beneficial uses.

3.4.5 Dissolved Oxygen

Dissolved oxygen (DO) concentrations shall conform to the following aquatic life requirements.

Beneficial Use	Daily Minimum Objective (mg/L)	7-Day Average Objective (mg/L)[8]
MAR, SAL	5.0	NA
WARM	5.0	6.0
COLD[9]	6.0	8.0
SPWN[10]	9.0	11.0

Dissolved oxygen concentrations in Humboldt Bay and Bodega Bay shall conform to a daily minimum objective of 6.0 mg/L. As required by the Ocean Plan, dissolved oxygen concentrations in ocean waters shall not at any time be depressed more than 10 percent from that which occurs naturally in ocean waters.

Upon approval from the Executive Officer, in those waterbodies for which the aquatic life-based DO requirements are unachievable due to natural conditions[11], site specific background DO requirements can be applied as water quality objectives by calculating the daily minimum DO necessary to maintain 85% DO saturation during the dry season and 90% DO saturation during the wet season under site salinity, site atmospheric pressure, and natural receiving water temperatures.[12] In no event may controllable factors reduce the daily minimum DO below 6.0 mg/L.

For the protection of estuarine habitat (EST), the dissolved oxygen concentration of enclosed bays and estuaries shall not be depressed to levels adversely affecting beneficial uses as a result of controllable water quality factors.

Dissolved oxygen concentrations for the Klamath River Watershed shall conform to the waterbody-specific objectives listed in Table 3-1a.

3.4.6 Floating Material

Waters shall not contain floating material, including solids, liquids, foams, and scum, in concentrations that cause nuisance or adversely affect beneficial uses.

3.4.7 Oil and Grease

Waters shall not contain oils, greases, waxes, or other materials in concentrations that result in a visible film or coating on the surface of the water or on objects in the water, that cause nuisance, or that otherwise adversely affect beneficial uses.

3.4.8 Pesticides

Waters shall not contain any individual pesticide or combination of pesticides in concentrations that cause nuisance or adversely affect beneficial uses. There shall be no bioaccumulation of

[8] A 7-day moving average is calculated by taking the average of each set of seven consecutive daily averages.
[9] Water quality objectives designed to protect COLD-designated waters are based on the aquatic life-based requirements of salmonids but apply to all waters designated in Table 2-1 of the Basin Plan as COLD regardless of the presence or absence of salmonids.
[10] Water quality objectives designed to protect SPWN-designated waters apply to all fresh waters designated in Table 2-1 of the Basin Plan as SPWN in those reaches and during those periods of time when spawning, egg incubation, and larval development are occurring or have historically occurred. The period of spawning, egg incubation, and emergence generally occur in the North Coast Region between the dates of September 15 and June 4.
[11] Natural conditions are conditions or circumstances affecting the physical, chemical, or biological integrity of water that are not influenced by past or present anthropogenic activities.
[12] The method(s) used to estimate natural temperatures for a given waterbody or stream length must be approved by the Executive Officer and may include, as appropriate, comparison with reference streams, simple calculation, or computer models.

pesticide concentrations found in bottom sediments or aquatic life.

Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of pesticides in excess of the numeric limits established in Title 22 and as prospectively incorporated in 3.4.3 Chemical Constituents**.**

3.4.9 pH

The pH shall conform to those limits listed in Table 3-1. For waters not listed in Table 3-1 and where pH objectives are not prescribed, the pH shall not be depressed below 6.5 nor raised above 8.5. Changes in normal ambient pH levels shall not exceed 0.2 units in waters with marine habitat (MAR) or inland saline habitat (SAL) beneficial uses nor 0.5 units within the range specified above in fresh waters with cold freshwater habitat (COLD) or warm freshwater habitat (WARM) beneficial uses.

3.4.10 Radioactivity

Waters shall not contain radionuclides in concentrations which are deleterious to human, plant, animal, or aquatic life nor which result in the accumulation of radionuclides in the food web to an extent which presents a hazard to human, plant, animal, or indigenous aquatic life

Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of radionuclides in excess of the numeric limits established in Title 22 and as prospectively incorporated in 3.4.3 Chemical Constituents.

3.4.11 Sediment

The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.

3.4.12 Settleable Material

Waters shall not contain substances in concentrations that result in deposition of material that causes nuisance or adversely affect beneficial uses.

3.4.13 Suspended Material

Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.

3.4.14 Tastes and Odors

Waters shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin, or that cause nuisance or adversely affect beneficial uses.

Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemicals in excess of the numeric taste and odor limits established in Title 22 and as prospectively incorporated in 3.4.3 Chemical Constituents.

3.4.15 Temperature

Temperature objectives for interstate waters associated with cold freshwater habitat (COLD), warm freshwater habitat (WARM), enclosed bays, and estuaries are as specified in the State Water Board *Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays of California* (Thermal Plan) including any revisions thereto. The Thermal Plan is available at the State Water Board website.

In addition, the following temperature objectives apply to surface waters:

The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses.

At no time or place shall the temperature of any waters associated with cold freshwater habitat (COLD) be increased by more than 5°F above natural receiving water temperature.

At no time or place shall the temperature of intrastate waters associated with warm freshwater habitat (WARM) be increased more than 5°F above natural receiving water temperature.

Waterbody-specific objectives for temperature in the Upper Trinity River are listed in Table 3-1b.

3.4.16 Toxicity

Waters shall not contain toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life. This objective applies regardless of whether the toxicity is caused by a single substance or the synergistic effect of multiple substances. Compliance with this objective shall be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, bioassays of appropriate duration, or other appropriate methods as specified by the Regional Water Board.

The survival of aquatic life in surface waters subjected to a waste discharge, or other controllable water quality factors, shall not be less than that for the same waterbody in areas unaffected by the waste discharge, or when necessary for other control water that is consistent with the requirements for "experimental water" as described in *Standard Methods for the Examination of Water and Wastewater,* latest edition (American Public Health Association, et al.). As a minimum, compliance with this objective shall be evaluated with a 96-hour bioassay.

In addition, effluent limits based upon bioassays of effluents will be prescribed, where appropriate. Additional numeric receiving water objectives for specific toxicants will be established as sufficient data become available and source control of toxic substances may be required.

3.4.17 Turbidity

Turbidity shall not be increased more than 20 percent above naturally occurring background levels. Allowable zones of dilution within which higher percentages can be tolerated may be defined for specific discharges upon the issuance of discharge permits or waiver thereof.

3.5 WATER QUALITY OBJECTIVES FOR GROUNDWATERS

Groundwater objectives consist primarily of narrative objectives combined with a limited number of numeric objectives. The following objectives shall apply to groundwaters[13] of the North Coast Region. Waterbody-specific objectives contained in Table 3-1 also apply.

Under existing law, the Water Board regulates waste discharges to land that could affect water quality, including both groundwater and surface water quality. Waste discharges that reach groundwater are regulated to protect both groundwater and any surface water in continuity with groundwater. Waste discharges that affect groundwater that is in continuity with surface water cannot cause violations of any applicable groundwater or surface water standards.

3.5.1 Bacteria

In groundwaters used for domestic or municipal supply (MUN), the median of the most probable number of coliform organisms over any 7-day period shall be less than 1.1 MPN/100 ml, less than 1 colony/100 ml, or absent (State Water Board Division of Drinking Water).

3.5.2 Chemical Constituents

In no case shall groundwaters contain concentrations of chemical constituents in amounts that cause nuisance or adversely affect beneficial uses.

Groundwaters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the following maximum contaminant level (MCL) and secondary maximum contaminant level (SMCL) provisions specified in Title 22 of the California Code of Regulations:

- Table 64431-A, MCLs - Inorganic Chemicals (§ 64431)
- Table 64444-A, MCLs - Organic Chemicals (§ 64444)
- Table 64449-A, SMCLs - "Consumer Acceptance Contaminant Levels" (§ 64449)
- Table 64449-B, SMCLs - "Consumer Acceptance Contaminant Level Ranges" (§ 64449)
- Table 64442, Radionuclide MCLs and Detection Levels for Purposes of Reporting (DLRs) (§ 64442)
- Table 64443, Radionuclide MCLs and
- DLRs (§ 64443)

These provisions are incorporated by reference into this Basin Plan. This incorporation by reference is prospective, including future changes to the incorporated provisions as the changes take effect.

Groundwater-specific numeric objectives for individual groundwaters are contained in Table 3-1.

3.5.3 Radioactivity

Groundwaters shall not contain concentrations of radionuclides in concentrations that cause nuisance or adversely affect beneficial uses.

Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of radionuclides in excess the numeric limits established in Title 22 and as prospectively incorporated in 3.5.2 Chemical Constituents.

[13] Groundwater is defined as subsurface water in soils and geologic formations that are fully saturated all or part of the year. Groundwater is any subsurface bodies of water which is beneficially used or usable.

3.5.4 Tastes and Odors

Groundwaters shall not contain taste- or odor-producing substances in concentrations that cause nuisance or adversely affect beneficial uses.

Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemicals in excess of the numeric taste and odor limits established in Title 22 and as prospectively incorporated in 3.5.2 Chemical Constituents.

3.5.5 Toxicity

Groundwaters shall not contain toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, humans or aquatic life[14] or that adversely impact beneficial uses. This objective applies regardless of whether the toxicity is caused by a single substance or the synergistic effect of multiple substances.

[14] The application of numeric values protective of aquatic life may be necessary where groundwater is hydraulically connected with surface waters. Groundwater includes perched water if such water is used or usable or is hydraulically continuous with used or usable water.

TABLE 3-1
SPECIFIC WATER QUALITY OBJECTIVES FOR THE NORTH COAST REGION

Waterbody[1]	Specific Conductance (micromhos) @ 77°F		Total Dissolved Solids (mg/L)		Hydrogen Ion (pH)		Hardness (mg/L)	Boron (mg/L)	
	90% Upper Limit[3]	50% Upper Limit[2]	90% Upper Limit[3]	50% Upper Limit[2]	Max	Min	50% Upper Limit[2]	90% Upper Limit[3]	50% Upper Limit[2]
Lost River HA									
Clear Lake Reservoir & Upper Lost River	300	200			9.0	7.0	60	0.5	0.1
Lower Lost River	1000	700			9.0	7.0	-	0.5	0.1
Other Streams	250	150			8.4	7.0	50	0.2	0.1
Tule Lake	1300	900			9.0	7.0	400	-	-
Lower Klamath Lake	1150	850			9.0	7.0	400	-	-
Groundwaters[4]	1100	500			8.5	7.0	250	0.3	0.2
Butte Valley HA									
Streams	150	100			8.5	7.0	30	0.1	0.0
Meiss Lake	2000	1300			9.0	7.5	100	0.3	0.1
Groundwaters[4]	800	400			8.5	6.5	120	0.2	0.1
Shasta Valley HA									
Shasta River	800	600			8.5	7.0	220	1.0	0.5
Other Streams	700	400			8.5	7.0	200	0.5	0.1
Lake Shastina	300	250			8.5	7.0	120	0.4	0.2
Groundwaters[4]	800	500			8.5	7.0	180	1.0	0.3
Scott River HA									
Scott River	350	250			8.5	7.0	100	0.4	0.1
Other Streams	400	275			8.5	7.0	120	0.2	0.1
Groundwaters[4]	500	250			8.0	7.0	120	0.1	0.1
Salmon River HA									
All Streams	150	125			8.5	7.0	60	0.1	0.0
Middle Klamath River HA									
Klamath River above Iron Gate Dam including Iron Gate & Copco Reservoirs [12]	425	275			8.5	7.0	60	0.3	0.2
Klamath River below Iron Gate Dam [12]	350	275			8.5	7.0	80	0.5	0.2
Other Streams	300	150			8.5	7.0	60	0.1	0.0
Groundwaters[4]	750	600			8.5	7.5	200	0.3	0.1
Applegate River HA									
All Streams	250	175			8.5	7.0	60	-	-
Upper Trinity River HA									
Trinity River	200	175			8.5	7.0	80	0.1	0.0
Other Streams	200	150			8.5	7.0	60	0.0	0.0
Trinity Lake & Lewiston Reservoir	200	150			8.5	7.0	60	0.0	0.0

TABLE 3-1
SPECIFIC WATER QUALITY OBJECTIVES FOR THE NORTH COAST REGION

Waterbody[1]	Specific Conductance (micromhos) @ 77°F		Total Dissolved Solids (mg/L)		Hydrogen Ion (pH)		Hardness (mg/L)	Boron (mg/L)	
	90% Upper Limit[3]	50% Upper Limit[2]	90% Upper Limit[3]	50% Upper Limit[2]	Max	Min	50% Upper Limit[2]	90% Upper Limit[3]	50% Upper Limit[2]
Hayfork Creek									
Hayfork Creek	400	275			8.5	7.0	150	0.2	0.1
Other Streams	300	250			8.5	7.0	125	0.0	0.0
Ewing Reservoir	250	200			8.0	6.5	150	0.1	0.0
Groundwaters[4]	350	225			8.5	7.0	100	0.2	0.1
S.F. Trinity River HA									
S.F. Trinity River	275	200			8.5	7.0	100	0.2	0.0
Other Streams	250	175			8.5	7.0	100	0.0	0.0
Lower Trinity River HA									
Trinity River	275	200			8.5	7.0	100	0.2	0.0
Other Streams	250	200			8.5	7.0	100	0.1	0.0
Groundwaters[4]	200	150			8.5	7.0	75	0.1	0.1
Lower Klamath River HA									
Klamath River[12]	300[6]	200[6]			8.5	7.0	75[5]	0.5[5]	0.2[5]
Other Streams	200[5]	125[5]			8.5	6.5	25[5]	0.1[5]	0.0[5]
Groundwaters[4]	300	225			8.5	6.5	100	0.1	0.0
Illinois River HA									
All Streams	200	125			8.5	7.0	75	0.1	0.0
Winchuck River HU									
All Streams	200[5]	125[5]			8.5	7.0	50[5]	0.0[5]	0.0[5]
Smith River HU									
Smith River-Main Forks	200	125			8.5	7.0	60	0.1	0.1
Other Streams	150[5]	125[5]			8.5	7.0	60[5]	0.1[5]	0.0[5]
Smith River Plain HSA									
Smith River	200[5]	150[5]			8.5	7.0	60[5]	0.1[5]	0.0[5]
Other Streams	150[5]	125[5]			8.5	6.5	60[5]	0.1[5]	0.0[5]
Lakes Earl & Talawa	-	-			8.5	6.5	-	-	-
Groundwaters[4]	350	100			8.5	6.5	75	1.0	0.0
Redwood Creek HU									
Redwood Creek	220[5]	125[5]	115[5]	75[5]	8.5	6.5			
Mad River HU									
Mad River	300[5]	150[5]	160[5]	90[5]	8.5	6.5			
Eureka Plain HU									
Humboldt Bay	-	-	-	-	8.5	Footnote 6			

TABLE 3-1
SPECIFIC WATER QUALITY OBJECTIVES FOR THE NORTH COAST REGION

Waterbody[1]	Specific Conductance (micromhos) @ 77°F		Total Dissolved Solids (mg/L)		Hydrogen Ion (pH)		Hardness (mg/L)	Boron (mg/L)	
	90% Upper Limit[3]	50% Upper Limit[2]	90% Upper Limit[3]	50% Upper Limit[2]	Max	Min	50% Upper Limit[2]	90% Upper Limit[3]	50% Upper Limit[2]
Eel River HU									
Eel River	375[5]	225[5]	275[5]	140[5]	8.5	6.5			
Van Duzen River	375	175	200	100	8.5	6.5			
South Fork Eel River	350	200	200	120	8.5	6.5			
Middle Fork Eel River	450	200	230	130	8.5	6.5			
Outlet Creek	400	200	230	125	8.5	6.5			
Cape Mendocino HU									
Bear River	390[5]	255[5]	240[5]	150[5]	8.5	6.5			
Mattole River	300[5]	170[5]	170[5]	105[5]	8.5	6.5			
Mendocino Coast HU									
Ten Mile River	-	-	-	-	8.5	6.5			
Noyo River	185[5]	150[5]	120[5]	105[5]	8.5	6.5			
Jug Handle Creek	-	-	-	-	8.5	6.5			
Big River	300[5]	195[5]	190[5]	130[5]	8.5	6.5			
Albion River	-	-	-	-	8.5	6.5			
Navarro River	285[5]	250[5]	170[5]	150[5]	8.5	6.5			
Garcia River	-	-	-	-	8.5	6.5			
Gualala River	-	-	-	-	8.5	6.5			
Russian River HU									
(upstream)[7]	320	250	170	150	8.5	6.5			
(downstream)[8]	375[5]	285[5]	200[5]	170[5]	8.5	6.5			
Laguna de Santa Rosa	-	-	-	-	8.5	6.5			
Bodega Bay	-	-	-	-	8.5	Footnote 6			
Coastal Waters[9]	-	-	-	-	Footnote 11	Footnote 11			

1 Waterbodies are grouped by hydrologic unit (HU), hydrologic area (HA), or hydrologic subarea (HSA).
2 50% upper and lower limits represent the 50 percentile values of the monthly means for a calendar year. 50% or more of the monthly means must be less than or equal to an upper limit and greater than or equal to a lower limit.
3 90% upper and lower limits represent the 90 percentile values for a calendar year. 90% or more of the values must be less than or equal to an upper limit and greater than or equal to a lower limit.
4 Value may vary depending on the aquifer being sampled. This value is the result of sampling over time, and as pumped, from more than one aquifer.
5 Does not apply to estuarine areas.
6 pH shall not be depressed below natural background levels.
7 Russian River (upstream) refers to the mainstem river upstream of its confluence with Laguna de Santa Rosa.
8 Russian River (downstream) refers to the mainstem river downstream of its confluence with Laguna de Santa Rosa.
9 The State Water Board Ocean Plan applies to all North Coast Region coastal waters.
10 Dissolved oxygen concentrations shall not at any time be depressed more than 10 percent from that which occurs naturally.
11 pH shall not be changed at any time more than 0.2 units from that which occurs naturally.
12 The Waterbody Specific Objectives (WSOs) for dissolved oxygen (DO) have been recalculated for the mainstem Klamath River and are presented separately in Table 3-1a.
\- no water-body specific objective available.

TABLE 3-1a[1]
WATERBODY-SPECIFIC OBJECTIVES FOR DISSOLVED OXYGEN (DO) IN THE MAINSTEM KLAMATH RIVER

Location[2]	Percent DO Saturation Based On Natural Receiving Water Temperatures[3]	Time Period
Stateline to the Scott River	90%	October 1 through March 31
	85%	April 1 through September 30
Scott River to Upstream Hoopa-California boundary	90%	Year round
Downstream Hoopa-California boundary to Turwar	85%	June 1 through August 31
	90%	September 1 through May 31
Upper and Middle Estuary	80%	August 1 through August 31
	85%	September 1 through October 31 and June 1 through July 31
	90%	November 1 through May 31
Lower Estuary	For the protection of estuarine habitat (EST), the dissolved oxygen content of the lower estuary shall not be depressed to levels adversely affecting beneficial uses as a result of controllable water quality factors.	

1 States may establish waterbody-specific objectives equal to natural background (USEPA, 1986. Ambient Water Quality Criteria for Dissolved Oxygen, EPA 440/5-86-033; USEPA Memo from Tudor T. Davies, Director of Office of Science and Technology, USEPA Washington, D.C. dated November 5, 1997). For aquatic life uses, where the natural background condition for a specific parameter is documented, by definition that condition is sufficient to support the level of aquatic life expected to occur naturally at the site absent any interference by humans (Davies, 1997). These DO objectives are derived from the T1BSR run of the Klamath TMDL model and described in Tetra Tech, December 23, 2009 *Modeling Scenarios: Klamath River Model for TMDL Development.* They represent natural DO background conditions due only to non-anthropogenic sources and a natural flow regime.

2 These objectives apply to the maximum extent allowed by law. To the extent that the State lacks jurisdiction, the Site Specific Dissolved Oxygen Objectives for the Mainstem Klamath River are extended as a recommendation to the applicable regulatory authority.

3 Corresponding DO concentrations are calculated as daily minima, based on waterbody-specific barometric pressure, water-specific salinity, and natural receiving water temperatures as estimated by the T1BSR run of the Klamath TMDL model and described in Tetra Tech, December 23, 2009. Modeling Scenarios: Klamath River Model for TMDL Development. The estimates of natural receiving water temperatures used in these calculations may be updated as new data or method(s) become available. After opportunity for public comment, any update or improvements to the estimate of natural receiving water temperature must be reviewed and approved by Executive Officer before being used for this purpose.

TABLE 3-1b WATERBODY-SPECIFIC OBJECTIVES FOR TEMPERATURE IN THE UPPER TRINITY RIVER		
Location/River Reach	**Daily Average Not to Exceed**	**Time Period**
Lewiston Dam to Douglas City Bridge	60°F	July 1 – September 14
	56°F	September 15 – October 1
Lewiston Dam to confluence of North Fork Trinity River	56°F	October 1 - December 31

Appendix D

This appendix contains the clean copy versions of the draft changes to Chapter 4 - Implementation Policies and Action Plans.

4. IMPLEMENTATION POLICIES AND ACTION PLANS

4.1 INTRODUCTION

This chapter presents the policies and action plans designed to achieve water quality objectives and protect beneficial uses of waters of the state in the North Coast. Measures shall be taken to restore, maintain, and protect ambient water quality conditions from actual and potential point and nonpoint sources of water quality degradation and other controllable factors.

Actions to achieve water quality objectives and support beneficial uses will require the coordinated efforts of the Regional Water Board, other agencies, non-governmental organizations, and regulated entities. An implementation program is an integral part of the Basin Plan. The implementation program is required to include, at a minimum, the following components:

- A description of the nature of the actions that are necessary to achieve the objectives, including recommendations for appropriate action by any entity, public or private
- A time schedule for the actions to be taken
- A description of surveillance to be undertaken to determine compliance with the objectives[1].

4.2 CONTROLLABLE WATER QUALITY FACTORS

Controllable water quality factors shall conform to the water quality objectives in this Basin Plan. When other factors result in the degradation of water quality beyond the levels or limits established as water quality objectives, controllable factors shall not cause further degradation of water quality. Controllable water quality factors are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the waters of the state and that may be reasonably controlled.

4.3 CONTROL ACTIONS

This section is intended to generally describe the authorities of the State Water Board, the Regional Water Board and other agencies with respect to water quality control.

4.3.1 Control Actions under State Water Board Authority

The State Water Resources Control Board (State Water Board) has adopted several statewide or area wide water quality plans and policies that complement or may supercede portions of this Basin Plan. These plans and policies may include water quality standards, implementation or control measures, water rights or monitoring requirements. See the State Water Board Website, “Plans and Policies,” for the full range of plans and policies adopted by the State Water Board.

4.3.2 Control Actions to be Implemented by Other Agencies with Water Quality or Related Authority

Water quality management plans prepared under Section 208 of the Federal Water Pollution Control Act (Clean Water Act) have been completed by various public agencies. These Section 208 plans, as well as other plans adopted by federal, state, and local agencies, may affect the Regional Water Board's water quality management and control activities. The Regional Water Board can also be party to official agreements with other agencies, such as memoranda of understanding (MOUs) or management agency agreements (MAAs) that recognize and rely on the water quality authority of other agencies.

[1] Wat. Code § 13242

4.3.3 Control Actions under Regional Water Board Authority

A program of implementation by the Regional Water Board must provide for the attainment of this Basin Plan's water quality standards (see Chapter 2, “Beneficial Uses,” and Chapter 3, “Water Quality Objectives,” and “Antidegradation Policies”), as well as any relevant water quality standards adopted by the State Water Board.

One of the primary ways in which the Regional Water Board regulates controllable water quality factors associated with discharges is through permits, orders, and other actions imposing waste discharge limitations on specific and general categories of discharges and potential discharges. Water quality objectives form the basis for the permits, orders and other actions that are pursuant to the Regional Water Board’s authority. These permits, orders, and other actions include, but are not limited to waste discharge requirements (including provisions required by federal law), waivers of waste discharge requirements, total maximum daily loads, water quality certifications, waste discharge prohibitions, and maximum acceptable cleanup levels.

4.3.4 Water Quality Certification

Under the Clean Water Act Section (CWA) 401 Water Quality Certification (Water Quality Certification), the Regional Water Board has broad authority to review proposed activities that require federal permits in and/or affecting “waters of the United States (U.S.)” within the Region. A Water Quality Certification is an order certifying that the proposed project will comply with CWA Sections 301 (Effluent Limitation), 302 (Water Quality Related Effluent Limitations), 303 (Water Quality Standards and Implementation Plans), 306 (National Standards of Performance) and 307 (Toxic Pretreatment Effluent Standards); will comply with applicable state laws; and, will be protective of beneficial uses identified within the Basin Plan. The Regional Water Board can then grant, condition, or deny certification of federal permits or licenses that may result in a discharge to waters of the U.S.

The Regional Water Board will refer to the following for guidance when permitting or otherwise acting on dredge or fill projects:

- Governor’s Executive Order W-59-93 (signed August 23, 1993; also known as the California Wetlands Conservation Policy);
- Senate Concurrent Resolution No. 28;
- Water Codes section 13142.5 (applies to coastal marine wetlands).

The goals of the California Wetlands Conservation Policy include ensuring “no overall net loss,” achieving a “long-term net gain in the quantity, quality, and permanence of wetlands acreage and value…”, and reducing “procedural complexity in the administration of state and federal wetlands conservation programs.”

Senate Concurrent Resolution No. 28 states, “It is the intent of the legislature to preserve, protect, restore, and enhance California’s wetlands and the multiple resources which depend on them for the benefit of the people of the state.”

Water Code section 13142.5 states, “Highest priority shall be given to improving or eliminating discharges that adversely affect…wetlands, estuaries, and other biological sensitive sites.”

4.3.5 National Pollutant Discharge Elimination System (NPDES)

NPDES permits are issued to regulate point source discharges of waste to “waters of the U.S.” including discharges of storm water from municipal separate storm sewer systems and certain categories of industrial activity. Waters of the U.S. are surface waters such as rivers, lakes, bays, estuaries, oceans, etc. The issuance of NPDES permits is authorized by Section 402 of the Clean Water Act and Section 13370 of the Water Code. The permit content and the issuance process are contained in the Code of

Federal Regulations (40 CFR Part 122) and Title 23, Chapter 9 of the California Code of Regulations, respectively. The U.S. Environmental Protection Agency (USEPA) has approved the state's program to regulate point source discharges of waste, including storm water, to waters of the U.S. The state, through the State and Regional Water Boards, issues the NPDES permits, reviews discharger self-monitoring reports, performs independent compliance checking, and takes enforcement actions as needed.

NPDES permits also require publicly owned treatment works to conduct pretreatment programs if their design capacity is greater than 5 million gallons per day. Smaller publicly owned treatment works may be required to conduct pretreatment programs if there are significant industrial users of their systems. The pretreatment programs must comply with the federal regulations at 40 CFR Part 403.

4.3.6 Waste Discharge Requirements (WDRs)

Waste Discharge Requirements (WDRs) are necessary for any persons discharging or proposing to discharge waste that could affect the quality of the waters of the state[2]. The Regional Water Board reviews the nature of the proposed discharge and adopts WDRs to protect the beneficial uses of waters of the state and to implement the Antidegradation Policy. Waste discharge requirements could be adopted as individual permits (e.g., for a particular facility), group permits (e.g., for facilities within a particular watershed), or general permits (e.g., for facilities conducting a particular activity) in accordance with Section 13263 of the Water Code. The Water Code authorizes Regional Water Boards to regulate discharges of waste to land to protect water quality by issuing WDRs. Regional Water Boards review self-monitoring reports submitted by the discharger, perform independent compliance checking, take enforcement actions as needed, and periodically review and update WDRs.

4.3.7 Waivers of WDRs

Regional Water Boards may conditionally waive WDRs if the Regional Water Board determines that such conditional waiver is in the public interest[3]. The requirement to submit a Report of Waste Discharge can also be waived. A conditional Waiver of WDRs may not exceed five years, and may be terminated at any time by the Regional Water Board. A Waiver of WDRs could be adopted as individual permits (e.g., for a particular facility), group permits (e.g., for facilities within a particular watershed), or general waiver (e.g., for facilities conducting a particular activity) in accordance with Section 13269 of the Water Code. Regional Water Boards issue Waivers of WDRs, review self-monitoring reports submitted by the discharger, perform independent compliance checking, and take enforcement actions as needed.

4.4 PROHIBITIONS AND EXCEPTIONS TO PROHIBITIONS

The Regional Water Board can prohibit specific types of discharges to certain areas[4]. These discharge prohibitions may be revised, rescinded, or adopted, as necessary. Discharge prohibitions are described in the “Waste Discharge Prohibitions” section of this Chapter. For certain circumstances, the Regional Water Board will allow exceptions to some of these prohibitions. Prohibition exceptions are further described in the “Waste Discharge Prohibitions” section of this Chapter.

4.5 MONITORING AND REPORTING

Monitoring and reporting programs are specified in the permits, orders, and other regulatory actions of the Regional Water Board or may be issued separately. Monitoring and reporting includes, but is not limited to, a description of the sampling and analytical methods, monitoring locations, and monitoring and reporting schedule necessary to determine compliance with the provisions of the permit, order, or other regulatory action, or the requirements of the Basin Plan. Where appropriate, the *Standard Methods for*

[2] Wat. Code § 13260
[3] Wat. Code § 13269
[4] Wat. Code § 13243

the Examination of Water and Wastewater, latest edition (American Public Health Association, et al.) generally applies.

4.6 COMPLIANCE WITH WATER QUALITY OBJECTIVES

It is not feasible to establish direction on compliance with water quality standards as appropriate for all circumstances and conditions which could be created by all discharges. Therefore, it is within the discretion of the Regional Water Board to establish direction on compliance with applicable water quality standards within individual or general permits, orders and other regulatory actions. Whenever the Regional Water Board finds that a discharge of waste violates or will violate requirements prescribed by the Regional Water Board or by the State Water Board, or waste treatment and/or disposal facilities are approaching capacity, the Regional Water Board may approve a time schedule of specific actions to correct and/or prevent a violation of requirements[5]. The Regional Water Board recognizes that immediate compliance with new effluent and/or receiving water NPDES permit limitations based on new, revised or newly interpreted water quality objectives or prohibitions adopted by the Regional Water Board or the State Water Board, or with new, revised or newly interpreted water quality criteria promulgated by the U.S. Environmental Protection Agency (USEPA)[6], may not be technically and/or economically feasible[7] in all circumstances. In such cases, the Regional Water Board may issue a time schedule order, as appropriate. Any schedule of compliance shall require achievement of the effluent limitations and/or receiving water limitations within the shortest feasible period of time. The issuance of an NPDES permit containing a compliance schedule will be in accordance with the State Water Board *Policy for Compliance Schedules in NPDES Permits*[8] and will result in discharge compliance with applicable requirements of the Clean Water Act.

4.7 ENFORCEMENT ACTIONS

The State Water Board has adopted the Water Quality Enforcement Policy to provide guidance that will enable Regional Water Board staff to expend its limited resources in ways that openly address the greatest needs, deter harmful conduct, protect the public, and achieve maximum water quality benefits. The Enforcement Policy articulates expectations and priorities for the State Water Board and nine Regional Water Boards. The Enforcement Policy includes several sections outlining consistent guidance to the Regional Water Boards that include: 1) Fair, Firm and Consistent Enforcement; 2) Enforcement Priorities for Discretionary Enforcement Actions; 3) Enforcement Actions; 4) State Water Board Enforcement Actions; 5) Coordination with Other Regulatory Agencies; 6) Monetary Assessment in Administrative Civil Liability (ACL) Actions; 7) Mandatory Minimum Penalties for NPDES Violations; 8) Compliance Projects; 9) Enhanced Compliance Actions; 10) Discharge Violation Reporting; 11) Violation and Enforcement Data; 12) Enforcement Reporting; and 13) Policy Review and Revision.

The Enforcement Policy outlines the various measures (formal and informal) to provide a consistent approach throughout the state. These measures can include the following types of actions.

[5] Wat. Code § 13300
[6] New, revised, or newly interpreted water quality objectives, criteria, or prohibitions means: 1) objectives as defined in Section 13050(h) of Porter-Cologne; 2) criteria as promulgated by the USEPA; or 3) prohibitions as defined in the Water Quality Control Plan for the North Coast Region that are adopted, revised, or newly interpreted after November 29, 2006. Objectives and criteria may be narrative or numeric.
[7] Technical and economic feasibility shall be determined consistent with State Board Resolution No. 92-49.
[8] State Water Board Resolution No. 2008-0025.

4.7.1 Informal Enforcement Actions

An informal enforcement action is any enforcement action taken by Regional Water Board staff that is not defined in statute or regulation. Informal enforcement action can include any form of communication (oral, written, or electronic) between Regional Water Board staff and a discharger concerning an actual, threatened, or potential violation. Informal enforcement actions cannot be petitioned to the State Water Board. Informal enforcement actions may include:

4.7.1.1. Oral and Written Contact

For many violations, the first step is an oral contact. This involves contacting the discharger by phone or in person and informing the discharger of the specific violations, discussing how and why the violations have occurred or may occur, and discussing how and when the discharger will correct the violation and achieve compliance.

4.7.1.2 Notice of Violation

A notice of violation or NOV is a letter formally advising a discharger in noncompliance that additional enforcement actions may be necessary if appropriate corrective actions are not taken. The NOV letter is the most significant level of informal enforcement action and should be used only where a violation has actually occurred. The NOV letter shall include a description of specific violation, a summary of potential enforcement options available to address noncompliance (including potential ACL assessments), and a request for a certified, written response by a specified date that either confirms the correction of the violation or identifies a date by which the violation will be corrected. The NOV can be combined with a request for technical information pursuant to Water Code section 13267.

4.7.2 Formal Enforcement Actions

Formal enforcement actions are statutorily based actions to address a violation or threatened violation of water quality laws, regulations, policies, plans, or orders. The actions listed below present options available for enforcement.

4.7.2.1 Notices to Comply

A Notice to Comply (Notice) can be issued for minor violations during field inspections by Regional Water Board staff, at the discretion of the inspector. Water Code section 13399 *et seq*. deals with statutorily defined “minor” violations. A violation is determined to be “minor” by the State Water Board or the Regional Water Board after considering factors defined in Water Code section 13399, subdivisions (e) and (f), and the danger the violation poses to, or the potential that the violation presents for endangering human health, safety, welfare, or the environment.

4.7.2.2 Notices of Stormwater Noncompliance

The Stormwater Enforcement Act of 1998 (Water Code section 13399.25 et seq.) requires that each Regional Water Board provide a notice of noncompliance to any stormwater dischargers who have failed to file a notice of intent to obtain coverage, a notice of non-applicability, a construction certification, or annual reports. If, after two notices, the discharger fails to file the applicable document, the Regional Water Board shall issue a complaint for administrative civil liability against the discharger. Alternatively, the Water Boards may enforce most of these violations under Water Code section 13385.

4.7.2.3 Technical Reports and Investigations

Water Code sections 13267, subdivision (b), and 13383 allow the Regional Water Board to conduct investigations and to require technical or monitoring reports from any person who has discharged, discharges, or is suspected of having discharged, or who proposes to discharge waste in accordance with the conditions in the section. When requiring reports pursuant to Water Code section 13267, subdivision (b), the Regional Water Board must ensure that the burden, including costs of the reports, bears a reasonable relationship to the need for the reports and the benefits to be obtained from them. Further, the Regional Water Board shall provide a written explanation with regard to the need for the reports and identify the evidence that supports requiring them.

4.7.2.4 Cleanup and Abatement Orders

Cleanup and Abatement Orders (CAOs) are adopted pursuant to Water Code section 13304. CAOs may be issued to any person who has discharged or discharges waste into the waters of this state in violation of any waste discharge requirement or other order or prohibition issued by a Regional Water Board or the State Water Board, or who has caused or permitted, causes or permits, or threatens to cause or permit any waste to be discharged or deposited where it is, or probably will be, discharged into the waters of the state and creates, or threatens to create, a condition of pollution or nuisance (discharger). The CAO requires the discharger to clean up the waste or abate the effects of the waste, or both, or, in the case of threatened pollution or nuisance, take other necessary remedial action, including, but not limited to, overseeing cleanup and abatement efforts.

4.7.2.5 Section 13300 Time Schedule Orders

Pursuant to Water Code section 13300, a Regional Water Board can require the discharger to submit a time schedule that sets forth the actions the discharger will take to address actual or threatened discharges of waste in violation of requirements. Typically, those schedules, after any appropriate adjustments by the Regional Water Board, are then memorialized in an order. Time Schedule Orders (TSOs) that require submission of technical and monitoring reports should state that the reports are required pursuant to Water Code section 13267.

4.7.2.6 Section 13308 Time Schedule Orders

Water Code section 13308 authorizes the Regional Water Board to issue a Time Schedule Order (13308 TSO) that prescribes, in advance, a civil penalty if compliance is not achieved in accordance with the time schedule. The Regional Water Board may issue a 13308 TSO if there is a threatened or continuing violation of a cleanup and abatement order, cease and desist order, or any requirement issued under Water Code sections 13267 or 13383. The penalty must be set based on an amount reasonably necessary to achieve compliance and may not contain any amount intended to punish or redress previous violations. The 13308 TSO provides the Regional Water Boards with their primary mechanism for motivating compliance, and if necessary, assessing monetary penalties against federal facilities. Orders under this section are an important tool for regulating federal facilities. If the discharger fails to comply with the 13308 TSO, the discharger is subject to a complaint for Administrative Civil Liability. The State Water Board may issue a 13308 TSO if the violation or threatened violation involves requirements prescribed by a State Water Board Order.

4.7.2.7 Cease and Desist Orders

Cease and Desist Orders (CDOs) are adopted pursuant to Water Code sections 13301 and 13303. CDOs may be issued to dischargers violating or threatening to violate WDRs or prohibitions prescribed by the Regional Water Board or the State Water Board. Section 4477 of the California Government Code prohibits all state agencies from entering into contracts of $5,000 or more for the purchase of supplies, equipment, or services from any nongovernmental entity who is the subject of a CDO that is no longer under review and that was issued for violation of WDRs or which has been finally determined to be in violation of federal laws relating to air or water pollution.

4.7.2.8 Modification or Rescission of WDRs

In accordance with the provisions of the Water Code, a Regional Water Board may modify or rescind WDRs in response to violations. Depending on the circumstances of the case, rescission of WDRs may be appropriate for failure to pay fees, penalties, or liabilities; a discharge that adversely affects beneficial uses of the waters of the state; and violation of the State Water Board General WDRs for discharge of bio-solids due to violation of the Background Cumulative Adjusted Loading Rate. Rescission of WDRs generally is not an appropriate enforcement response where the discharger is unable to prevent the discharge, as in the case of a POTW.

4.7.2.9 Administrative Civil Liabilities

Administrative Civil Liabilities (ACLs) are monetary liabilities imposed by a Regional Water Board or the State Water Board. The Water Code authorizes the imposition of an ACL for certain violations of law. The factors used to assess the appropriate penalties are addressed in Section VI of the Enforcement Policy. It is the policy of the State Water Board that a 30 day public comment period shall be posted on the Regional Water Board website prior to the settlement or imposition of any ACL, including mandatory minimum penalties, and prior to settlement of any judicial civil liabilities. In addition, for civil liabilities that are expected to generate significant public interest, the Regional Water Board may consider mailing or e-mailing the notice to known interested parties, or publishing the notice in a local newspaper.

POINT SOURCE MEASURES

No modifications to the following sections were made.

Appendix E

Peer Review Draft Staff Report for the Revision of Dissolved Oxygen Water Quality Objective

PEER REVIEW DRAFT

STAFF REPORT
FOR THE
REVISION OF DISSOLVED OXYGEN
WATER QUALITY OBJECTIVES

March 2009

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CHAPTER I. INTRODUCTION

The North Coast Regional Water Quality Control Board (Regional Water Board) directed staff in its triennial review of the Water Quality Control Plan for the North Coast Region (Basin Plan) in 2007 to develop a proposal for the revision of the dissolved oxygen (DO) objectives contained in the Basin Plan. This report includes staff's proposal and the scientific documentation necessary to support the proposal both for the purposes of the Regional Water Board's decision making process and the public's environmental review under the California Environmental Quality Act (CEQA).

Staff distributed a CEQA Scoping Document for public review in September 2008 and held two CEQA Scoping Meetings in October 2008. This staff report and proposed Basin Plan Amendment are drafted with consideration of the public comments received during the CEQA scoping process. The Regional Water Board will hold a hearing to provide opportunity to interested parties to comment on the proposed Basin Plan Amendment and supporting documentation prior to the Board's decision regarding adoption of the amendment. Following this, the State Water Resources Control Board (State Water Board) will hold a hearing in preparation for their decision regarding adoption of the amendment. Finally, the Office of Administrative Law (OAL) will provide a legal review of the amendment before forwarding it to the U.S. Environmental Protection Agency (USEPA) for final approval.

I.1 Description of Region

As described in the Basin Plan, the North Coast Region encompasses a total area of approximately 19,390 square miles, including 340 miles of scenic coastline and remote wilderness areas, as well as urbanized and agricultural areas. The region is characterized by distinct temperature zones. Along the coast, the climate is moderate and foggy and the temperature variation is not great. Inland, however, seasonal temperatures in excess of 100 °F have been recorded. Precipitation over the North Coast Region (greater than for any other part of California) in combination with the mild climate found over most of the region has provided a wealth of fish, wildlife, and scenic resources. The mountainous nature of the region, with its dense coniferous forests interspersed with grassy or chaparral covered slopes, provides shelter and food for numerous terrestrial animal species. The numerous streams and rivers contain anadromous fish and the reservoirs, although few in number, support both coldwater and warm water fish. Tidelands and marshes too are extremely important to many species of waterfowl and shore birds, as are cultivated lands (NCRWQCB 2007).

I.2 Background Information on Existing DO Objectives

The Regional Water Board adopted and the State Water Board approved the first comprehensive management plan in 1975 which was revised and became known in 1988 as the Basin Plan. Objectives for DO were included in the 1975 plan and have remained unchanged since that time. The DO objectives are contained in two places within the Basin Plan: 1) page 3-4.00 under the heading "Dissolved Oxygen" and 2) Table 3-1 on pages 3-6.00 through 3-8.00. (See Appendix A for a copy of these pages).

The DO objectives on page 3-4.00 (referred to here as the *life cycle DO objectives*) are based on the life cycle requirements of sensitive aquatic species and are applicable in waterbodies throughout the region based on the designated beneficial use(s) of individual waterbodies. There are four separate life cycle DO objectives, each designed to protect specific beneficial uses: 1) WARM[1], MAR[2], or SAL[3]; 2) COLD[4]; 3) SPWN[5]; and 4) SPWN during critical spawning and egg incubation periods.

The objectives in Table 3-1 of the Basin Plan are based on background conditions (referred to here as *background DO objectives*) as measured by extensive regional sampling in the 1950s and 1960s and are applicable in individually named waterbodies. The background DO objectives take precedence over the life cycle DO objectives for those waterbodies named in Table 3-1 of the Basin Plan.

I.3 Revision of Existing DO Objectives

Staff's assessment indicates as appropriate three fundamental changes to the existing DO objectives. First, the framework of the DO objectives should be reversed so that the life cycle DO objectives take precedence over the background DO objectives. Staff recommends this change because of the threatened and endangered status of several aquatic species in the region and the need to ensure water quality conditions are fully supportive of all beneficial uses. Further, staff recommends this change because the data associated with the DO requirements of sensitive aquatic organisms is robust and guidance on the development of ambient aquatic life criteria straightforward, while the data used to determine background DO conditions are outdated as compared to current monitoring capabilities.

Second, the life cycle DO objectives should be updated to include weekly average limits so as to better prevent the occurrence of multiple days of marginal, stressful conditions. When the daily minimum limits are reached periodically, no harm is predicted. However, when they are reached for several days or weeks at a time, chronic effects are possible, including reduction in reproductive success, reduction in growth, and greater susceptibility to disease. To protect against this, staff propose the adoption of weekly average limits to accompany daily minimum limits.

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[1] WARM stands for Warm Freshwater Habitat and refers to uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

[2] MAR stands for Marine Habitat and refers to uses of water that support marine ecosystems, including, but not limited to, preservation or enhancement of marine habitats, vegetation such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds).

[3] SAL stands for Inland Saline Water Habitat and refers to uses of water that support inland saline water ecosystems including, but not limited to, preservation or enhancement of aquatic saline habitats, vegetation, fish, or wildlife, including invertebrates.

[4] COLD stands for Cold Freshwater Habitat and refers to uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

[5] SPWN stands for Spawning, Reproduction, and/or Early Development and refers to uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

Third, in those waterbodies where natural conditions prevent the attainment of life cycle objectives, the background DO objectives must be updated. The Table 3-1 objectives are based on background conditions as represented by grab sample data collected in the 1950s and 1960s. These data reflect the influence of the land management activities present at the time, including: mining, logging, agriculture, dams, and more. Further, the data do not capture the minimum DO conditions over a 24-hour period because they were collected primarily during daylight hours when the effects of photosynthesis generally cause a rise in DO concentrations. Finally, there is insufficient data on a region-wide scale to allow for the recalculation of the Table 3-1 objectives. As such, staff recommends that the existing background DO objectives be replaced with a method for individually calculating background DO conditions based on DO saturation. Specifically, staff recommends that background DO concentrations be calculated based on an estimate of natural temperatures, existing salinity, and existing barometric pressure.

I.4 Staff Report Outline

The Staff Report includes the following information:

1. An introduction;
2. A review of the existing DO objectives;
3. A general discussion of DO and its interaction and function in the environment;
4. A discussion of the native fish species of the North Coast Region and their water quality requirements;
5. An assessment of the existing DO objectives and staff recommendations;
6. Discussion of Project Alternatives and identification of staff's Preferred Alternative;
7. A monitoring plan; and
8. An implementation plan.

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CHAPTER II.
EXISTING WATER QUALITY OBJECTIVE FOR DISSOLVED OXYGEN

The Regional Water Board adopted and the State Board approved the first comprehensive management plan in 1975 which was revised and became known in 1988 as the Basin Plan. Objectives for DO were adopted in 1975 and have remained unchanged since that time. The DO objectives are contained in two places within the Basin Plan: 1) page 3-4.00 under the heading *Dissolved Oxygen* and 2) Table 3-1 on pages 3-6.00 through 3-8.00. (See Appendix A for a copy of these pages).

II.1 Life Cycle DO Objectives

The DO objectives on page 3-4.00 of the Basin Plan, the life cycle DO objectives, are based on the life cycle requirements of sensitive aquatic species (salmonids) and are applicable in waterbodies throughout the region based on the designated beneficial use(s) of individual waterbodies. The Porter-Cologne Water Quality Control Act, (Cal. Water Code, Division 7), Section 13050(f), defines beneficial uses as follows:

> "Beneficial uses" of the waters of the state that may be protected against quality degradation include, but are not limited to, domestic, municipal, agricultural and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves.

Life cycle DO objectives are developed for the protection of five beneficial uses related to the preservation and enhancement of fish: marine habitat (MAR), inland saline water habitat (SAL), warm freshwater habitat (WARM), cold freshwater habitat (COLD), and spawning, reproduction, and/or early development (SPWN).

Table 2-1 of the Basin Plan (see Appendix B for a copy of these pages) lists all of the waterbodies in the North Coast region and their beneficial uses. There are 132 separate waterbodies listed in Table 2-1. Of these, 13% (17) are designated as existing or potentially existing marine habitat, 2% (2) as existing or potentially existing inland saline water habitat, 49% (64) as existing or potentially existing warm freshwater habitat, 98% (129) as existing or potentially existing cold freshwater habitat, and 95% (125) as existing or potentially existing spawning, reproduction, and/or early development. Of the beneficial uses related to the preservation and enhancement of fish, then, COLD and SPWN are the most widely represented.

The Basin Plan establishes ambient water quality objectives for DO, as follows.

- ✓ 5.0 mg/L DO as a daily minimum for the protection of MAR, SAL, and WARM.
- ✓ 6.0 mg/L DO as a daily minimum for the protection of COLD.
- ✓ 9.0 mg/L DO as a daily minimum for the protection of SPWN during critical spawning and egg incubation periods and 7.0 mg/L DO as a daily minimum for the protection of SPWN during the rest of the year.

II.2 Background DO Objectives

The second set of DO objectives included in the Basin Plan is found in Table 3-1 of the Basin Plan (see Appendix A). They are based on background conditions as measured by extensive regional sampling in the 1950s and 1960s and are applicable in individually named waterbodies. The data used to establish background conditions were collected by a range of partners including federal, state and local agencies. The Department of Water Resources published the data in annual bulletins beginning with data from 1951. Generally, the data are monthly grab samples that were collected during day light hours and analyzed in the field using the Winkler titration method.

The objectives in Table 3-1 of the Basin Plan are referred to as background DO objectives and take precedence over the life cycle DO objectives in those waters listed in Table 3-1. For waterbodies from the Stemple Creek north up to but not including the Klamath River, the background DO objective is 7.0 mg/L as a daily minimum, except in Humboldt and Bodega bays which are assigned a background DO objective of 6.0 mg/L as a daily minimum. A 90% lower limit of 7.5 mg/L and a 50% lower limit of 10.0 mg/L, based on the monthly means for a calendar year, also apply in these waterbodies.

For waterbodies from the Klamath River up to the Oregon border, the background DO objectives range from 5.0 mg/L to 9.0 mg/L as a daily minimum, depending on the waterbody. A 50% lower limit ranging from 8.0 to 10.0 mg/L, based on the monthly means for a calendar year, also applies. There are no 90% lower limits for these waterbodies.

II.3 Relationship Between Life Cycle and Background DO Objectives

As the Basin Plan is currently structured, the background DO objectives take precedence over the life cycle DO objectives for those waterbodies listed in Table 3-1. This structure is based on the principle that beneficial uses are protected by maintaining the background conditions in which they have historically existed. Only for those waterbodies not listed in Table 3-1 do the life cycle DO objectives apply.

It is important to note that for those waterbodies draining to the Pacific Ocean from the Klamath River to the Oregon border, the DO objectives listed in Table 3-1 apply to all the streams within a named hydrologic area, including tributaries. This is indicated in the Table 3-1 language with the terms "streams," "other streams," or "all streams." For those waterbodies draining to the Pacific Ocean south of the Klamath River, however, the DO objectives listed in Table 3-1 apply only to those streams specifically named. This is indicated by the absence of terms such as "streams," "other streams," or "all streams." The difference in approach between waterbodies south of the Klamath River and those north of and including the Klamath River is an artifact of the original Basin Plan having been developed by two separate consultants as two separate documents.

CHAPTER III. GENERAL DISCUSSION OF DISSOLVED OXYGEN

Dissolved Oxygen (DO) provides an excellent measure of general aquatic health. It is one of the primary water quality factors that define the habitability of a given aquatic system. Yet, it varies considerably both temporally and spatially in the natural environment. Thus, to interpret DO data, one must know something about the factors influencing its concentration and the expected pattern and range of its variation to be able to discern any deviation from background conditions and/or any critical impact. A general discussion of these issues follows.

III.1 What is Dissolved Oxygen?

Dissolved oxygen, most often measured in mg/L, is the amount of oxygen gas present in a volume of water. Water has a limited capacity to hold oxygen gas in solution. This capacity is defined by a mathematical relationship among the temperature, atmospheric pressure, and salinity at a given site. When water has reached its capacity to hold oxygen gas in solution it is said to be *saturated.* When it exceeds its capacity, it is said to be *supersaturated.* And, when it does not reach its capacity, it is said to be *subsaturated.*

III.2 Why is dissolved oxygen important?

Oxygen is necessary for the respiration of aerobic organisms. Because water has a limited capacity to hold oxygen gas in solution, aquatic organisms have evolved specialized structures or methods of extracting from water the limited amount of oxygen gas that is present in it. These structures or methods generally rely on the partial pressure differential between oxygen in the water column and oxygen in the blood (or the equivalent oxygen receptor). Gills, as an example, are designed to allow the passive diffusion of oxygen from water across the gill membrane to the arterial system.

A healthy riverine system is generally one in which the DO concentration is at or approaches full saturation and maintained by diffusion (Allan1995). Under these conditions, aerobic organisms can extract from the water column the oxygen necessary to ensure basic metabolic success (e.g., growth, general health, and reproduction) leading to a greater likelihood of population success. Further, a riverine system approaching DO saturation is better able to support a wide and diverse array of life forms than one which does not.

As the concentration of DO in water is reduced to levels significantly less than saturation, the oxygen partial pressure gradient between the water column and blood (or equivalent oxygen receptor) is reduced and the ability of the gill structure (or equivalent oxygen receptor) to acquire the necessary oxygen for respiration is impaired. This can lead to chronic effects, such as reduced growth, increased susceptibility to disease, reduced reproductive success, or loss of habitat through avoidance. It can also lead to acute effects, such as asphyxiation and death. The term *hypoxia* (meaning "low oxygen") refers to the water quality condition in which the dissolved oxygen present in water is insufficient to provide the oxygen requirements of aerobic organisms. Water devoid of oxygen is known as *anoxic.*

III.3 What are the factors influencing the concentration of dissolved oxygen?

The concentration of DO in an aquatic environment is controlled by many interrelated variables, including stream temperature, salinity, barometric pressure, turbulence, respiration, photosynthesis, and biological and chemical oxygen demanding reactions. To simplify, these factors can be divided two categories: 1) those that define the capacity of the water to hold DO (DO saturation) and 2) those that affect the percent of that capacity which is actually utilized (% DO saturation).

III.3.1 DO saturation

DO saturation is defined by the mathematical relationship among three variables: atmospheric pressure, temperature, and salinity. Variation in DO saturation is proportional with variation in atmospheric pressure and is inversely proportional with variation in temperature and salinity. Thus, as atmospheric pressure increases so does the concentration of DO at saturation. Because atmospheric pressure decreases as elevation increases, DO at saturation is inversely proportional with elevation. At any one elevation, DO at saturation also will vary based on the presence of low or high pressure storm systems. As water temperature and/or salinity increase, the concentration of DO at saturation decreases. Water temperature varies depending on numerous factors including: latitude, climate, season, presence of springs, shade, and volume of warm water inputs, as examples. Salinity primarily varies based on the degree of oceanic influence.

One of the primary routes by which oxygen dissolves in water is through the diffusion of oxygen across the air-water interface. Atmospheric oxygen exerts a pressure at the air-water interface allowing for the diffusion of oxygen across the boundary until the partial pressure of atmospheric oxygen equals the partial pressure of oxygen in water. The pressure exerted on the air-water interface by oxygen dissolved in water is defined not only by the concentration of oxygen in water, but by the temperature of the water, as well. For example, O_2 molecules become excited and exert a greater partial pressure on the air-water interface when warm then they do when cool. Thus, the warming of a waterbody serves to slow or even reverse the diffusion of oxygen from the air to the water column.

With respect to salinity, one can visualize water as including H_2O molecules and the spaces between them. The spaces between the H_2O molecules allow for various other molecules to be dissolved in water. If the spaces between the H_2O molecules are filled with molecules such as salts, then the number of spaces available for oxygen is reduced. Salinity is a measure of salts and is generally used to define the gradient between freshwater, brackish water, and saltwater systems. An aquatic system with a high salinity (e.g., the ocean) will naturally have a lower DO concentration at saturation than will a freshwater system with little or no salinity.

III.3.2 Percent Saturation

In the natural environment, there are several other factors at play besides the effects of atmospheric pressure, temperature, and salinity. For example, photosynthesis, turbulence, respiration, organic decomposition, and oxygen demanding chemical reactions also effect the concentration of DO in an aquatic system. These factors do not control the capacity of an aquatic system to hold oxygen in solution (DO saturation). Instead, they affect the percentage of the capacity that is actually utilized (percent saturation).

The photosynthesis of aquatic plants, algae, and cynobacteria has a profound effect on the oxygen content of water. Photosynthetic organisms use carbon dioxide to convert the energy contained in sunlight into carbohydrates and oxygen. Aquatic photosynthetic organisms release their oxygen (a waste product) to the water column, temporarily increasing the DO concentration of the water. Areas in which the substrate, light, nutrients and temperature favor the growth of aquatic photosynthetic organisms may see large increases in DO during the late afternoon when the effects of photosynthesis have accumulated through the day. Such areas may be naturally present in an aquatic system (e.g., wetlands; lakes; and slow moving, shallow river reaches) or promoted by anthropogenic activities (e.g., nutrient enrichment, shade removal, reduction in flow, or reduction in water depth through sediment deposition).

The contribution of oxygen to the water column as a result of photosynthesis occurs only during the daylight hours when photosynthesis is active. This source of oxygen is not present during the night when in the absence of sunlight photosynthesis does not occur. The result is a notable cyclical DO pattern where DO is low in the pre-dawn hours, increases slowly during the morning, reaches a peak prior to sunset, and then declines through the night. This is called a *diel* cycle.

The term *turbulence* refers to a physical process in which the air-water interface is disturbed. Turbulence serves to increase the transfer of oxygen across the air-water interface by increasing the surface area of the interface either at the surface of the water or in the form of bubbles of air entrained within the water column (e.g., as occurs at waterfalls or through mechanical mixing). Turbulence can serve to either decrease or increase the transfer of oxygen to the water column depending on whether the water is supersaturated or subsaturated and whether or not air is entrained in the water column.

The respiration of aquatic organisms requires oxygen for the process of converting carbohydrates into energy for growth and reproduction. It also results in the release of carbon dioxide as a waste product. The oxygen fueling the respiration of aquatic organisms comes from the water column and as described above is extracted using specialized structures or methods (e.g., gills). Respiration exerts a continual pressure on dissolved oxygen supplies.

The decomposition of organic matter in the aquatic environment is a complex process involving numerous organisms and chemical reactions. Biological oxygen demand is a measure of the pressure exerted on dissolved oxygen supplies by the biological decomposition of organic molecules. Numerous species of micro-organisms are involved in the process of biological decomposition.

Chemical oxygen demand is a measure of the pressure exerted on dissolved oxygen supplies by the chemical oxidation of organic molecules. Some of the reactions are initiated by biological activity. The chemical reactions typically at play in an aquatic environment include: carbonaceous deoxygenation, nitrogenous deoxygenation, nitrification, and methantrophy. Appendix C includes an excerpt from the Shasta River TMDL (NCRWQCB 2006) summarizing these processes.

III.4 Conceptual Model for DO

The USEPA's CADDIS (Causal Analysis/Diagnostic Decision Information System) has produced a conceptual model for dissolved oxygen depicting the potential linkages between and among various environmental and anthropogenic factors.

As depicted in Figure 1, the causal pathways potentially resulting in dissolved oxygen impairment include: 1) channel alteration; 2) land cover alteration; 3) water impoundment; and, 4) chemical, organic matter, and nutrient loading. Increased stream temperatures, increased ionic strength, and/or increased sediment loading are interacting stressors that can further exacerbate DO impairment. The biotic responses of concern include changes in behavior, increased mortality, impairment of invertebrate assemblages, impairment of fish assemblages, and other biological impairments. Increased susceptibility to disease, decreased growth, and decreased fecundity are also biotic responses of concern, though not specifically indicated in this model. A more complete conceptual model is included in Appendix D.

The following is USEPA's written explanation of the conceptual model

> "Certain human activities, such as agricultural, residential, and industrial practices, can contribute to DO depletion (or, less frequently, DO supersaturation), and subsequent biological impairment. These practices may directly introduce chemical contaminants, organic loading, and nutrients to streams, via point and non-point sources such as wastewater treatment plant effluents, fertilizers, animal wastes, landfills, and septic systems. Increases in these substances can increase chemical and biochemical oxygen demand, most notably due to increased respiration of plants and especially microbes.
>
> Physical alteration of the stream channel, through impoundments or channel alterations, can contribute to low dissolved oxygen concentrations in several ways. For example, an impoundment downstream of a location will slow water velocities and increase water depths, which will tend to reduce turbulence and lower incorporation of oxygen into the water column via aeration, as well as reduce diffusion of oxygen from the atmosphere. Channel incision also reduces oxygen diffusion due to decreases in surface-to-volume ratio with increasing stream depth. An impoundment upstream of a location (upper far right of diagram) may reduce DO levels if downstream water releases come from deeper, oxygen-depleted waters of the reservoir (i.e., if they are hypolimnetic), but may

increase DO levels if discharges are highly turbulent; whether DO levels increase or decrease will depend on impoundment size and type of release.

Land cover alterations also may reduce stream DO levels by altering in-stream physical characteristics. For example, decreases in riparian vegetation often associated with these activities can reduce large woody debris inputs to the channel, reducing turbulence and aeration; homogenization of stream substrates can have similar effects. In addition these alterations may increase delivery of chemical contaminants, organic material, and nutrients to streams with surface runoff.

In addition to these processes discussed above, DO concentrations are closely linked to several other stressors...Nutrient enrichment stimulates oxygen-generating (photosynthesis) and oxygen-depleting (respiration) processes. DO levels also are affected by water temperature, ionic strength, and dissolved solids: oxygen solubility decreases as these parameters increase, reducing the amount of available DO in the water. Increased bedded sediment can decrease interstitial flow, reducing oxygen availability for sediment-dwelling organisms, and decreases in water velocity can lower oxygen delivery rates.

DO concentrations directly impact abiotic and biotic stream environments. Low DO...affects the oxidation and reduction (redox) reactions which determine the bioavailability of many inorganic compounds, as well as biologically important materials such as nitrogen and sulfur. For example, lower redox potential (↓ Eh) may decrease the release of precipitated metals, which actually may benefit organisms by reducing bioavailability); however, it also may increase the release of precipitated phosphates, encouraging the proliferation of nitrogen-fixing cyanobacteria and potentially altering food resources for fish and invertebrate assemblages.

The most direct effect of low DO is respiratory distress in biota, which may be exacerbated by relatively rapid fluctuations in available DO. During periods of low DO, some species may increase movement to enhance ventilation across gill structures, attempt to gulp air from the surface, or gather around photosynthesizing plants. Respiratory stress can cause low DO-sensitive taxa [e.g., EPT taxa, or Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddis flies), and salmonid fishes] to decrease; often these taxa are considered indicators of good water quality. Decreases in low DO-sensitive life stages also are potential indicators. Conversely, more tolerant organisms (e.g., cyprinids, amphipods, and chironomids with hemoglobin) and life stages may increase. Increased populations of plant-breathers (e.g., insects that can obtain air from plants, such as certain beetle larvae) and air-breathers (e.g., insects that can carry air bubbles with them underwater) also may be observed. If DO depletion is significant enough, widespread fish kills may occur.

Although biological impairments related to dissolved oxygen usually result from insufficient DO levels, too much DO, or supersaturation, also may pose a problem in certain situations. This supersaturation may result from extremely high levels of oxygen-generating photosynthesis, or from extremely high turbulence and aeration downstream of impoundments. Ultimately, these rapid or large increases in DO may affect organisms by contributing to stressful fluctuations in DO levels, altering redox potentials and bioavailability of potentially toxic substances (e.g., metals), or leading to gas bubble disease (a condition indicated by gas bubbles forming under skin and around eyes) (CADDIS 2007)."

With respect to the kind of activities generally found in the North Coast Region, the conceptual model highlights the importance of evaluating and controlling anthropogenic inputs of chemicals, nutrients, and organic rich wastes. But, it also highlights the importance of evaluating and managing the effects of:

- ✓ Anthropogenic alteration to the natural pattern and range of flows, including stormwater management, groundwater protection, and control of water impoundment and withdrawal;
- ✓ Anthropogenic sources of erosion and sediment delivery;
- ✓ Anthropogenic loss of channel forming materials (e.g., large woody debris);
- ✓ Alteration of the stream channel, such as through gravel mining;
- ✓ Disturbance to wetlands, the flood plain and riparian zone;
- ✓ Anthropogenic sources of nutrients, organic matter, warm water and their delivery to a waterbody, including the discharge of agricultural return flows; and,
- ✓ Threat of loss or alteration (e.g., reduction in flow or increase in temperature) of cold water springs.

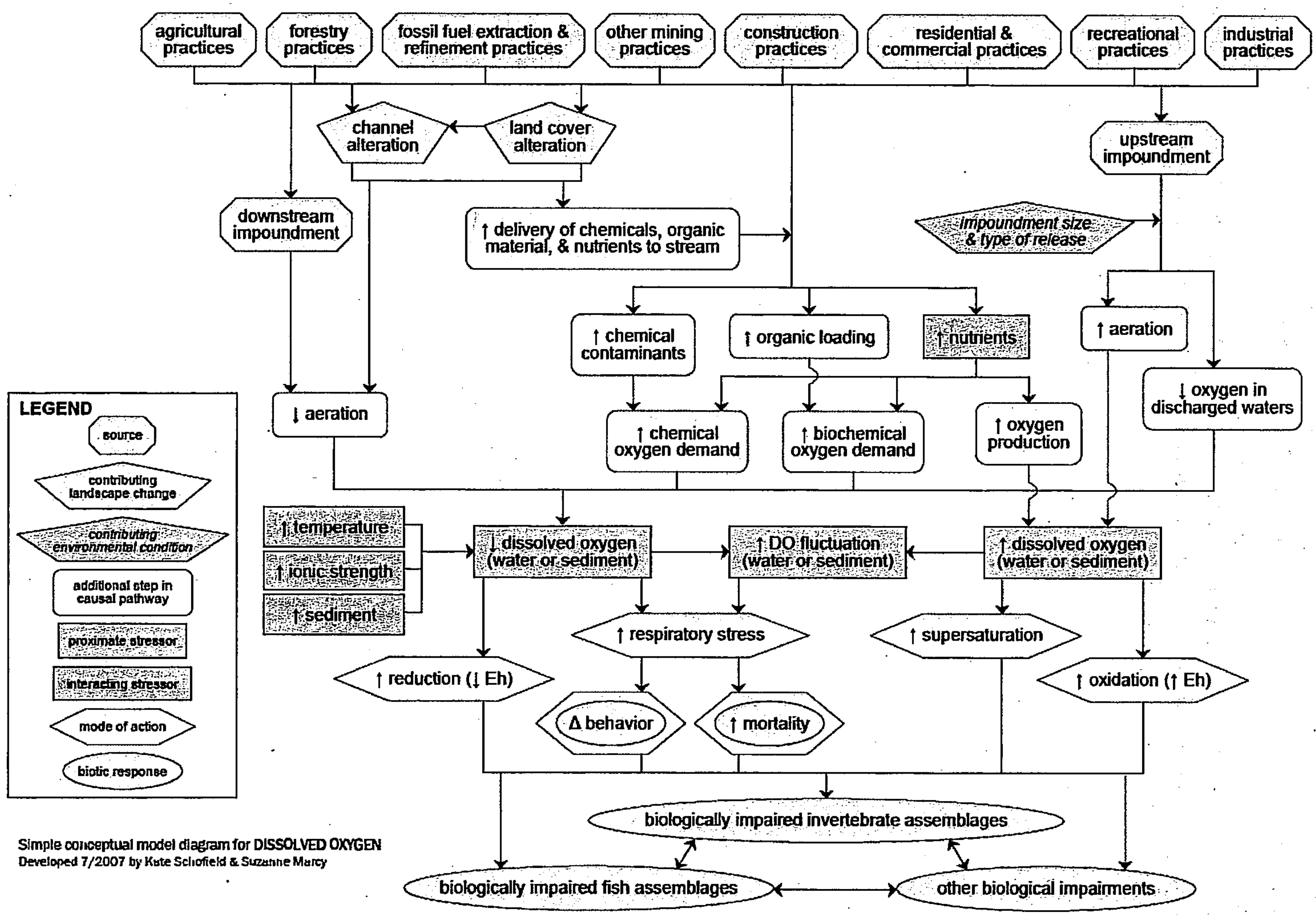
III.5 How is dissolved oxygen measured?

Dissolved oxygen measurements were historically collected as grab samples and analyzed in the field using the Winkler or modified Winkler method. The method requires careful sampling to avoid aeration, acid fixation, and slow titration to measure a change in test color. During the 1950 and 1960s when the State of California engaged in extensive water quality monitoring, one sample per site was typically collected during a sampling trip with site sample times varying across the hours of the work day.

More recently, DO has been measured using a datasonde data logger (datasonde). The Regional Water Board, for example, owns several datasondes used both by Regional Water Board staff and other local partners for specific field studies. A datasonde measures the current resulting from the electrochemical reduction of oxygen diffusing through a selective membrane (HACH 2008a). It is capable of collecting and storing data at intervals over several days. There are issues with calibration drift and biofouling of the membrane when the device is deployed for multiple days, making quality assurance a particularly important aspect of the data collection effort. The advantage of the datasonde over the Winkler method is that data can be collected over a 24-hour period (or longer). Thus, with this sampling method, it is possible to ascertain the true daily minimum DO value, since it often occurs at night.

Even more recently, dissolved oxygen data collection methods have been further improved with the development of Luminescent Dissolved Oxygen technology.. The use of this new technology is not yet widespread. But, it is expected to replace the earlier membrane-based probes in the coming year (Fadness 2008). Luminescent Dissolved Oxygen technology has a thicker membrane than its predecessor and is thus less susceptible to biofouling. It is also reported to have the ability to hold a calibration without drift (HACH 2008b). Data can be collected with this device at intervals over a 7-day period (or longer), thus allowing for assessment not only of the daily minimum, but daily and weekly averages, as well.

Figure 1 CADDIS Conceptual Model for DO



CHAPTER IV.
FISHERIES OF THE NORTH COAST REGION

As described by Moyle (2002) the North Coast Region is divided into two zoogeographic provinces representing two distinct fauna: the Klamath Province and the North Coast Province. The Klamath Province includes the Upper Klamath Subprovince, the Lower Klamath Subprovince, the Rogue River Subprovince, and the Klamath-Pit fishless area. The North Coast Province includes all the rivers draining to the Pacific Ocean north of the Klamath River basin to the Oregon border, as well as those south of the Klamath River to San Francisco Bay.

IV.1 Klamath Province

Moyle (2002) describes the native fishes of the Upper Klamath Province as primarily freshwater dispersants "most having their closet relatives in the Great Basin." A freshwater dispersant is a species that arrived in its present location from a freshwater route or has evolved in place from a distant saltwater ancestor (Moyle 2002). Freshwater dispersants in the Upper Klamath Province arrived from the Great Basin due to a time in geologic history when an ancestor of the Snake River, now draining through the Columbia River, previously flowed through the Klamath Region (Aalto et al. 1998 as cited by Moyle 2002). The native fishes of the Upper Klamath Province include three species of sucker; three species of cyprinids (i.e., blue chub, Klamath tui chub, speckled dace); three species of sculpin; several species of salmonid (e.g., bull trout, rainbow trout, redband trout, coastal rainbow trout, and the now extinct Chinook salmon); and three species of lamprey (Moyle 2002). Of these, the Klamath River lamprey, Lost River sucker, shortnose sucker, and slender sculpin are at risk of extinction (Moyle 2002). The slender sculpin, however, only occurs in Klamath and Agency lakes in Oregon.

The Lower Klamath Province includes 21 native species of fish including: three species of lamprey, two species of sturgeon, one cyprinid (speckled dace), one sucker, two species of smelt, six species of salmonid (the pink salmon now extinct), one stickleback, four species of sculpin, and one flounder. Of these, the river lamprey, green sturgeon, eulachon, longfin smelt, chum salmon, coho salmon, and cutthroat trout are at risk of extinction (Moyle 2002).

The Rogue River Subprovince contains the same saltwater dispersant species as in the lower Klamath River and the only native freshwater dispersant is the Klamath smallscale sucker (Moyle 2002). A saltwater dispersant is a species that lives in the freshwater environment; but, it either can live some portion of its life in saltwater or has immediate ancestors that did. The saltwater dispersants found in California are anadromous or had ancestors who were anadromous (Moyle 2002).

The Klamath-Pit fishless area is comprised of a large region of lava geology and scrubby forest and no flowing waterbody (Moyle 2002). Much of the rainfall to this area feeds underground springs that form the Fall River, a tributary to the Pit River (Moyle 2002).

IV.2 North Coast Province
The rivers of the North Coast Province each have slightly different zoogeographic histories; but, Moyle (2002) describes them as having more faunal similarities than differences. Moyle (2002) highlights the following North Coast basins: Tomales Bay, Russian River, Gualala River, Garcia River, Navarro River, Big River, Noyo River, Mattole River, Bear River, Eel River, Mad River, Little River, Redwood Creek, and the Smith River. Of these, only the Tomales Bay resides outside of the boundaries of the North Coast Region.

The native fish common to most of these rivers include: Pacific lamprey, coho salmon, rainbow trout, threespine stickleback, staghorn sculpin, coastrange sculpin, and prickly sculpin. Of these, Moyle (2002) lists the coho salmon at risk of extinction.

The Russian River uniquely includes several species of fish also endemic to the Sacramento-San Joaquin basins of the Central Valley, including: hardhead, hitch, Sacramento pikeminnow, California roach, Sacramento sucker, longfin smelt, tule perch, riffle sculpin, and starry flounder (Moyle 2002). Moyle (2002) describes the Russian River as having "captured" much of the Central Valley fauna. California roach are also found in the Gualala and Navarro Rivers (Moyle 2002). The Sacramento sucker has made its way into the Navarro, Big, Bear, Eel, and Mad Rivers and Redwood Creek (Moyle 2002).

Moyle (2002) identifies those species at risk of extinction in the North Coast Province as including:

- River lamprey (in the Russian and Eel rivers),
- Pacific brook lamprey (in the Russian and Eel rivers),
- Hitch (in the Russian River),
- Eulachon (in the Mad River, Redwood Creek, and Smith River),
- Longfin smelt (in the Russian River),
- Coho salmon (throughout the Province),
- Chinook salmon (in the Russian, Mattole, Bear, Eel, Mad, Little, and Smith Rivers, and Redwood Creek),
- Tule perch (in the Russian River), and
- Tidewater goby (in the Eel River, Redwood Creek, and Smith River).

The green sturgeon and longfin smelt are already extinct in the Eel River; pink salmon are extinct in the Russian River, Eel River, and Mad River; and Chinook salmon is extinct in the Garcia River (Moyle 2002).

IV.3 Individual Life Histories
The following is a list of native fishes identified as being at risk of extinction in the North Coast Region, including both the Klamath Province and the North Coast Province (Moyle 2002). While they share the status of being at risk, they also represent a range of fish species and life histories. What follows is a discussion of the individual life histories and

DO requirements, to the degree that they are known. Predictably, the DO requirements of salmonids are the most well understood and represent the largest part of the discussion. Because coldwater DO objectives have generally been developed based on the requirements of salmonids, the information below is intended to confirm whether or not DO objectives developed to protect salmonids will protect the other fishes at risk, as well.

- Salmonids (chum salmon, coho salmon, Chinook salmon, cutthroat trout);
- Lamprey (Klamath River lamprey, river lamprey, Pacific brook lamprey);
- Sucker (Lost River sucker, shortnose sucker);
- Green sturgeon;
- Hitch;
- Smelt (eulachon and longfin smelt);
- Tule perch; and
- Tidewater goby.

IV.3.1 Salmon

The present distribution and abundance of salmonids "have been strongly shaped by Pleistocene events. In northern and mountain areas, they followed the advance and retreat of continental glaciers, rapidly colonizing new steams and lakes" (Moyle 2002). Moyle (2002) asserts that salmonids thrive in dynamic environments. But, the water must be fairly cool (<22°C maximum) and well oxygenated (Moyle 2002). Moyle (2002) opines that because they have twice as much genetic material as most fishes, salmonids respond rapidly to evolutionary pressures.

Salmonids are anadromous fish, being born in freshwater, migrating to the ocean where they feed and mature, and returning to their natal freshwater stream to reproduce. Salmonids typically die after spawning in fresh water. Salmonid eggs are laid in a nest (i.e., redd) that the female digs in the gravel. The eggs are fertilized externally and the developing embryos covered with gravel as protection. After the yolk sac fry or alevin hatch, they remain in the interstices of the gravel until ready for emergence to the water column. Juvenile fish grow in freshwater until ready for outmigration to the ocean. They remain in the estuary where they develop osmoregulation facilities capable of life in the ocean. Once in the ocean they feed and grow before reaching sexual maturity. Some salmonids complete their sexual maturation in the freshwater of their natal stream. Others return to their natal stream ready to spawn.

Salmonid species differ in the timing of their life cycle stages, as well as the specific habitat niches they inhabit while in the freshwater environment. For example, spring Chinook enter a river system in the spring while fall Chinook enter a river system in the fall. However, both species wait until water flows increase and water temperatures decline in the fall before building redds and laying eggs. Other salmonid species arrive throughout the fall and winter for spawning. By June, the fry of all salmonid species have emerged from the gravel and begun their life in the water column. The length of time juvenile fish remain in freshwater before outmigrating to the ocean varies from several months to several years.

IV.3.1.1 Coho Salmon
In California, coho salmon (*Oncorhynchus kisutch*) have a fairly strict 3 year life cycle with about half of its life spent in freshwater and the other half in the ocean (Moyle 2002). Coho adults migrate upstream for spawning after heavy fall or winter rains breach the sandbars of coastal streams allowing the fish to enter. Coho choose smaller coastal streams or the tributaries of larger coastal streams for spawning. They continue upstream when stream flows are rising or falling; though, not necessarily when the streams are in full flood (Moyle 2002). Redd locations generally are at the head of riffles, just below a pool, "where water changes from smooth to turbulent flow and there is abundant medium to small gravel" (Moyle 2002). Embryos hatch after 8-12 weeks of incubation, time being "inversely related to water temperature" (Moyle 2002).

After emergence, fry find quiet stream margins to feed and shelter before establishing territories. Nielsen (1992a, 1992b, and 1994) as cited by Moyle 2002, documented a complicated division of territories amongst coho juveniles, including distinctions between those she called estuarine, margin, thalweg, and early pulse juveniles. All are as their name implies: "early pulse juveniles show two pulses of growth, one in spring and one in autumn (Moyle 2002)."

The outmigration of juveniles begins between March and May. The triggers include: "rising or falling water levels, day length, water temperature, food densities, phase of the moon, and dissolved oxygen levels" (Moyle 2002). Migrants transform into silvery smolts often lingering for a period in the estuary while adjustments are made to their osmoregulatory system (Moyle 2002).

IV.3.1.2 Chinook Salmon
In California, Chinook salmon (*Oncorhynchus tshawytscha*) are often described by the timing of their freshwater migration: fall-run, late fall-run, winter-run, and spring-run (Moyle 2002). Widely recognized runs in the North Coast Region include: Smith River fall run (and spring run), Klamath-Trinity fall run, Klamath-Trinity spring run, Klamath late fall run, Redwood Creek fall run, Little River fall run, Mad River fall run, Humboldt Bay tributary fall run, Eel River fall run, Bear River fall run, Mattole River fall run, and Garcia River fall run (Moyle 2002). Stream-type Chinook are fish that migrate upstream before reaching sexual maturity, as well as juveniles that spend more than 1 year in freshwater before outmigrating (Moyle 2002). Ocean-type Chinook are fish that spawn immediately upon migrating upstream, as well as juveniles that spend less than 1 year in freshwater before outmigrating (Moyle 2002).

A fall-run Chinook is an ocean-type Chinook, entering the big rivers of the Klamath and North Coast Provinces in the late summer and early fall, and spawning in the lowland reaches within a few days to weeks or arrival (Moyle 2002). Juveniles emerge from the gravel in spring and move downstream within a few months to rear in the mainstem or estuary before going out to sea (Moyle 2002).

A spring-run Chinook is a stream-type Chinook, entering the Smith, Klamath or Eel River in the spring or early summer, going as far upstream as it can, and holding in deep, cold pools until spawning in the early fall (Moyle 2002). The juveniles rear for 3-15 months depending on flow conditions (Moyle 2002). Spring-run Chinook are considerably less abundant that fall-run Chinook because of the presence of dams, blocking much of their historical mid-elevation habitat (Moyle 2002).

IV.3.1.3 Chum Salmon

In California, small runs of chum salmon were historically present in streams from the Sacramento River north (Moyle 2002). Today, small runs of chum salmon continue in the Smith, Klamath and Trinity Rivers. Chum salmon are generally ocean-type salmon, spending little time in freshwater, and most of that often in the estuary. Chum salmon enter freshwater in the late fall with optimal spawning temperatures of 7.2-12.8 °C and oxygen levels greater than 80% saturation (Moyle 2002).

IV.3.1.4 Cutthroat Trout

In California, coastal cutthroat trout live in the coastal drainages from the Eel River north (Moyle 2002). Coastal cutthroat trout are more strongly tied to fresh water than most anadromous fishes, leaving freshwater only in the summer months, if at all, and returning to overwinter in freshwater (Moyle 2002). They live primarily in small, low-gradient coastal streams and estuaries where temperatures are cool (<18 °C), well-shaded, and there is abundant cover (Moyle 2002). They especially avoid waters with DO <5 mg/L (Moyle 2002). Embryo survival can be reduced to less than 10% with DO levels lower than 6.9 mg/L (Moyle 2002). Cutthroat trout migrate upstream in August-October following the first substantial rainfall (Moyle 2002). Embryos hatch after 6-7 weeks of incubation and alevin remain in the gravel for an additional 1-2 weeks (Moyle 2002), emerging from March to June (Moyle 2002).

IV.3.1.5 DO requirements of early life stages

In her review of scientific literature on the subject of DO requirements for salmonids, Regional Water Board staff Carter (2005) found that the early life stages of salmonids (embryos and alevins) are particularly vulnerable to poor water quality conditions because of their relative immobility within the gravel and their underdeveloped ability to extract oxygen from the environment. The effects of low DO on fish eggs and larvae include: respiratory dependence, retarded growth, reduced yolk sac absorption, developmental deformities, and mortality (Davis 1975).

The DO present in the intragravel environment is a function of many chemical, physical, and biological factors, including: the DO concentration of the overlying water, water temperature, substrate size and porosity, biochemical oxygen demand, sediment oxygen demand, the gradient and velocity of the stream, channel configuration, and depth of water (Carter 2005). In streams with substantial groundwater inflows, however, DO concentrations and flow patterns of intragravel water may not relate in the usual way to substrate composition and permeability (Bjornn and Reiser 1991). In fact, Bjornn and Reiser (1991) determine that unhatched embryos can extract the necessary oxygen from the air within a dewatered redd, as long as the environment is otherwise moist.

Koski (1965), as cited by USEPA (1986), found that even within the same redd, intragravel DO concentrations varied 5 or 6 mg/L in 30 coho salmon redds studied in 3 small, unlogged, forested watersheds. But, the average intraredd DO concentration was about 2 mg/L below that of the overlying water while the minimum concentrations averaged about 3 mg/L below those of the overlying water. USEPA (1986) recommends ambient water quality objectives be set 3 mg/L higher than intragravel DO requirements to ensure protection of embryos and alevin.

In its review of the scientific literature, ODEQ (1995), as cited by Carter (2005), found that the mortality of salmonid embryos held at a constant 10 °C began to increase dramatically as DO concentrations were reduced below 3 mg/L. Silver et al. (1963) as cited by Carter (2005) found that survival of a large percentage of embryos was possible even at 2.5 mg/L by a reduction in respiration rates. But, this resulted in a concurrent reduction in growth and development rates.

Embryo survival rates have been correlated with DO concentration: 62 % survival of steelhead embryos at 9.25 mg/L DO and 16% survival at 2.6 mg/L DO (Coble 1961 as cited by Carter 2005). But, at temperatures suitable to Chinook salmon incubation, percent survival remained high as DO concentrations were reduced from 11 mg/L to 3.5 mg/L (Eddy 1971 as cited by Carter 2005). The number of days to hatching increased, however, while the mean dry weight of the fry decreased substantially (Eddy 1971 as cited by Carter 2005).

Salmonid embryos were found to be smaller than normal and hatching either delayed or premature when DO was less than saturation throughout development (Bjorrn and Reiser 1991). Shumway et al. (1964), as cited by Carter (2005), found that the median time to hatching decreased and size of fry increased as DO levels increased.

Once embryos hatch, alevin reside in the intragravel environment until their yolk sac is absorbed and they are ready to emerge from the gravel as fry. To some degree, they are able to move between particles within the intragravel environment to locate preferred water quality conditions. The Washington State Department of Ecology (WDOE 2002), as cited by Carter (2005), found that alevin showed a strong preference for DO concentrations of 8-10 mg/L, avoiding areas where DO was 4-6 mg/L.

Bjornn and Reiser (1991), suggest that an average intragravel DO concentration of 8 mg/L allows for good embryo and alevin survival. Davis (1975), as cited by Carter (2005), concludes that 9.75 mg/L is necessary for full protection of larvae and mature eggs. USEPA (1986) determines that no production impairment is expected when intragravel DO conditions average 8 mg/L. The daily minimum intragravel DO should not be reduced below 6 mg/L.

IV.3.1.6 DO requirements to support juvenile growth

As described by Carter (2005) food conversion efficiency is related to DO concentrations and the process becomes less efficient when DO is less than 4-4.5 mg/L (ODEQ 1995 as cited by Carter 2005). Bjornn and Reiser (1991) as cited by Carter (2005) state that growth, food conversion efficiency, and swimming performance are adversely affected when DO concentrations are less than 5 mg/L. Brett and Blackburn (1981) as cited by Carter (2005) demonstrated that both coho and sockeye salmon growth is strongly dependent on DO concentration up to 5 mg/L. Growth rates are independent of DO at concentrations greater than 5 mg/L, however. Herrmann et al. (1962) as cited by Carter (2005), concluded that a reduction in the mean oxygen levels from 8.3 mg/L to 6 and 5 mg/L resulted in slight decreases in food consumption and growth. USEPA (1986) as cited by Carter 2005) calculated no reduction in growth at DO concentrations of 8 an 9 mg/L and 1% reduction in growth at 7 mg/L, with reductions in growth rates seen above 6 mg/L generally not statistically significant.

IV.3.1.7 DO requirements to support swimming

Davis (1975), as cited by Carter 2005, reviewed numerous studies and reported no impairment to rearing salmonids if DO concentrations averaged 9 mg/L, while at levels of 6.5 mg/L, "the average member of the community will exhibit symptoms of oxygen distress." Davis et al. (1963) as cited by Carter 2005, reported maximum sustained swimming speeds of wild juvenile coho salmon held in the laboratory were reduced when DO dropped below saturation at water temperatures between 10-20 °C. WDOE (2002), as cited by Carter 2005, concluded that swimming fitness is maximized when the daily minimum DO levels are above 8 mg/L.

IV.3.1.8 DO preference

Field and laboratory studies have found that avoidance reactions in juvenile salmonids consistently occur at concentrations of 5 mg/L and lower, with some indication that avoidance is triggered at concentrations as high as 6 mg/L (Carter 2005). Spoor (1990), as cited by Carter 2005, concluded that brook trout will avoid oxygen concentrations below 4 mg/L and preferred oxygen levels of 5 mg/L or higher. Salmonid mortality occurs when DO concentrations are below 3 mg/L for periods longer than 3.5 days (USEPA 1986, as cited by Carter 2005).

IV.3.2 Lamprey

Lamprey are a jawless fish from the family *Petromyzontidae* that generally feed on the blood and body fluids that they extract with their sucker-like mouth from live fish (Moyle 2002). This "predatory" phase of the Pacific lamprey is spent in the ocean, except for those species that are landlocked (Moyle 2002).

Pacific lamprey spawning usually begins in early March and lasts through late June (Moyle 2002). There are variations to this schedule. And, in the larger rivers (Klamath, Trinity, and Eel) there may be both spring and fall runs, similar to salmon (Moyle 2002).

Adult lamprey migrate from the ocean to freshwater where a male and female build a nest together in the gravel (Moyle 2002). After the eggs are laid and fertilized, embryos develop and hatch in about 19 days at 15 °C (Moyle 2002). The ammocoetes are washed downstream to a muddy or sand-bottomed backwater where they burrow in the sediment, tail down (Moyle 2002). They remain in the sediment as filter feeders while they undergo a metamorphosis to become adult lamprey (Moyle 2002). Metamorphosis takes from 5-7 years (Moyle 2002).

There is some evidence of temperature requirements of lamprey. But, little information is available regarding dissolved oxygen requirements, though ammocoete development is impaired under very low DO concentrations (Goodman 2008). Of primary concern to lamprey conservation are activities that may directly disturb ammocoetes, result in sedimentation of quiescent stream reaches, or cause localized dewatering (USFWS 2007). DO conditions suitable to support salmonids are believed to be adequate for lamprey, as well (Goodman 2008).

IV.3.3 Sucker

The Lost River sucker (*Catostomus luxatus*) and shortnose sucker (*Chasmistes brevirostris*) are two native species of the upper Klamath basin. Both sucker species are endangered and belong to a "part of a group of suckers that are large, long-lived, late-maturing, and live in lakes and reservoirs but spawn primarily in streams; collectively, they are commonly referred to as lake suckers" (NRC 2004). Lake suckers differ from most other suckers in having terminal or subterminal mouths that open more forward than down, an apparent adaptation for feeding on zooplankton rather than suctioning food from the substrate (Scoppettone and Vinyard 1991 as cited by NRC 2004). Historically, Lost River suckers and shortnose suckers occurred in the Lost River and upper Klamath River and their tributaries, especially Tule Lake, Upper Klamath Lake, Lower Klamath Lake, Sheepy Lake, and their tributaries (Moyle 2002 and USFWS 2002 as cited by NRC 2004).

The adult suckers reach sexual maturity between years 4 and 6 for the shortnose sucker (USFWS 2007c) and 5 and 14 for the Lost River sucker (USFWS 2007b). They spawn in river riffle and run habitat from February through May in gravel and cobble substrate with moderate flows and depths less than 4 feet (USFWS 2007b and 2007c). Sucker larvae move out of the gravel soon after hatching and generally drift downstream to the lake environment where they disperse in the near shore areas (Cooperman and Markle 2004 as cited by USFWS 2007a; USFWS 2007b). Larval habitat is best described as shallow, nearshore, and vegetated in both rivers and lakes, except Clear Lake and Gerber Reservoir which lack vegetation (Klamath Tribe 1991, Markle and Simon 1994, and Reiser et al. 2001 as cited by NRC 2004). Adult suckers select water depths of 3-15 feet, their strongest preference appears to be for 5-11 feet (Reiser et al. 2001 and USFWS 2002 as cited by NRC 2004). Adult Lost River suckers have been aged to 43 years while shortnose suckers have been aged to 33 years (NRC 2004). The lake suckers spawn numerous times over their life time producing millions of eggs, a life history strategy necessary due to the high natural mortality of the young fish and the low natural mortality of the older adult fish (NRC 2004).

With respect to water quality, Woodhouse et al. (2004) synthesized several studies in the Lost River basin to determine appropriate thresholds for Lost River and shortnose suckers. In summary, water quality threshold values include:

- DO > 2.3 mg/L (based on LC_{50} in shortnose sucker larvae);

- pH < 9.5 (based on critical maxima in shortnose sucker adults);
- Water temperature < 30.3 °C (based on LC50 in shortnose sucker juveniles);
- Un-ionized ammonia < 0.48 mg/L (based on LC_{50} in Lost River sucker larvae and shortnose sucker juveniles).

Staff concludes that DO conditions suitable for the protection of salmonids will adequately protect suckers, as well.

IV.3.4 Green Sturgeon

The green sturgeon (*Acipsenser medirostris Ayres*) is a long-lived anadromous fish that spends most of its time in ocean waters with feeding forays to bays and estuaries (NMFS 2009). Both adults and juveniles are benthic feeders eating shrimp, mollusks, amphipods and small fish (Moyle 2002). The green sturgeon migrates into freshwater systems to spawn. In the North Coast Region, green sturgeon are primarily found in the Klamath and Trinity rivers; though, they will occasionally be seen in the Eel River which once supported a spawning run (Moyle 2002).

Green sturgeon enter the Klamath River system between February and late July with a spawning period of March to July and a peak from mid-March to mid-June (Moyle 2002). They spawn in deep, fast water where eggs are broadcast and externally fertilized (Moyle 2002). Juveniles remain in freshwater for up to 3 years before migrating to the ocean. Water quality requirements for the green sturgeon are unknown; but, a small amount of silt will prevent the eggs from clumping together and thus reduce viability (Moyle 2002). Gulf of Mexico sturgeon were found in locations in the Suwannee River estuary ranging from 6.0 to 9.8 mg/L DO with an average of 7.5 mg/L DO (Harris et al. 2005). Eggs were found in areas of the Suwannee River with DO exceeding 5.0 mg/L (Sulak and Clugston 1998). Campbell and Goodman (2004) exposed juvenile shortnose sturgeon, an Atlantic species, to varying laboratory conditions and derived LC50s ranging from 2.2-3.1 mg/L DO depending on the accompanying salinity, temperature, and age of the fish. Younger fish were more sensitive to low DO than older fish.

NMFS 2009 lists as threats to California's green sturgeon:

- ✓ Insufficient freshwater flow rates in spawning areas,
- ✓ Contaminants (e.g., pesticides),
- ✓ Bycatch of green sturgeon in fisheries,
- ✓ Potential poaching (e.g., for caviar),
- ✓ Entrainment by water projects,
- ✓ Influence of exotic species,
- ✓ Small population size,
- ✓ Impassable barriers, and
- ✓ Elevated water temperatures.

Staff concludes that DO requirements designed to protect salmonids will reasonably protect sturgeon, as well.

IV.3.5 Smelt

The eulachon (*Thaleichthys pacificus*) and longfin smelt (*Spirinchus thaleichthys*) are both in the smelt family *Osmeridae* and are anadromous fish. Within the North Coast River, the eulachon has been found historically in the Klamath River, as well as in the Mad River, Redwood Creek, and the Smith River while the longfin smelt has been found in Humboldt Bay, the Eel River estuary, the Klamath river estuary, and the Russian River estuary (Moyle 2002).

The eulachon is the largest example of the smelt family (Moyle 2002). It is a very oily fish, also sometimes called the candlefish because of its historic use when dried to be burned as a candle. It is an anadromous fish, spending most of its life at sea and then spawning in the lower reaches of coastal rivers (Moyle 2002). Eulachon return to freshwater between December and May in their third year and their migration appears to be timed with river temperatures between 4-8 °C (Moyle 2002). Migrating fish seldom travel farther than 12 km up river, the fish keeping to the river bottom and shallow river edges (Moyle 2002). Spawning occurs where temperatures are between 4-10 °C, velocities are moderate, and substrate consists of pea-sized gravel or gravel mixed with sand, wood or other debris (Moyle 2002). Fertilization is external with females producing an average of 25,000 eggs (Moyle 2002). Eggs have two membranes, the outer one of which ruptures when the egg hits the channel bottom. This allows the sticky edges to adhere to the substrate where the larvae will hatch in 2-3 weeks. The larvae are quickly washed out to sea (Moyle 2002).

Moyle (2002) states "given the extended ocean life phase of eulachon and the apparently sporadic nature of their abundance in recent years, it is likely that oceanic conditions may be important determinants of the size of spawning runs." He continues "eulachon are sensitive to a number of environmental factors and their recent decline in California streams may be the result of changes in water quality or spawning habitat in the lower reaches of rivers" (Moyle 2002).

Longfin smelt have a wide salinity and temperature range, reflecting their ability to occupy various estuarine niches depending on the time of year and life cycle stage (Moyle 2002). They spawn in freshwater over sandy or gravel substrates, rocks and aquatic plants as early as November and up through the month of June (Moyle 2002). Embryos hatch in 40 days at temperatures of 7 °C, the newly hatched larvae drift quickly down to the estuary (Moyle 2002). Larvae metamorphose into juveniles after 30-60 days from hatching, depending on the temperature (Moyle 2002). Most adult longfin smelt die after spawning (Moyle 2002).

Pientka and Parrish (2002) found that in a comparison of habitat use by Atlantic salmon and rainbow smelt, the two occupied similar thermal habitat. But, Atlantic salmon generally chose habitat with higher DO concentrations. Staff concludes that DO objectives designed to protect salmonids will be protective of smelt, as well.

IV.3.6 Tule Perch

The UC Cooperative Extension, Fish Web Site lists Bodega Bay, Gualala River-Salmon Creek watershed (i.e., coastal streams from the Gualala River to Salmon Creek in

Sonoma County), and Russian River as locations in the North Coast Region where tule perch are found (UCCE 2009). They prefer low elevation lakes, streams, and estuarine environments, requiring well oxygenated water with temperatures below 22 °C and have high salinity tolerances (UCCE 2009). Numeric DO criteria for tule perch were not immediately available. However, Moyle (2002) notes that yellow perch can survive DO levels of less than 1 mg/L.

In rivers, tule perch occupy deep pools with complex cover, particularly overhanging vegetation (UCCE 2009). In lakes, they tend towards deep water with a slight current, as well as near stands of tule (UCCE 2009). Tule perch bear live young in emergent vegetation during the period of May to June (UCCE 2009). The young grow rapidly in the first 18 months and may reach up to 7 years of age, though the majority live about 5 years (UCCE 2009).

Staff conclude that tule perch are likely to be well-protected by DO objectives designed to protect salmonids.

IV.3.7 Hitch

Hitch (*Lavinia exilicauda*) are in the minnow family (Cyprinidae) and are closely related to California roach (Moyle 2002). Hitch are widespread in warm, low-elevation lakes, sloughs, and slow-moving stretches of river, and in clear, low-gradient streams (Moyle 2002). They also have wide temperature and salinity tolerances, e.g. up to 38 °C and 9 ppt, respectively (Moyle 2002).

Adult fish are pelagic, feeding on algae, insects, and/or zooplankton (Moyle 2002). But, juveniles are found in shallow-water habitat under the protection of vegetation such as tule where they eat insect larvae and pupae and planktonic crustaceans (Moyle 2002). Spawning takes place in riffles of streams tributary to lakes, rivers and sloughs, after flows increase in response to spring rains (Moyle 2002). In Clear Lake, spawning migrations take place from mid-March through May and occasionally into June (Moyle 2002). Females release their eggs over clean gravel where 1-5 males then fertilize them. Eggs sink into the gravel, absorb water, and swell up to 4 times their original size to lodge in the gravel (Moyle 2002). Hitch eggs hatch in 3-7 days and larvae become free-swimming in another 3-4 days (Moyle 2002). In Clear Lake, juveniles quickly move into the lake, allowing spawning in tributaries that otherwise dry up as the summer proceeds (Moyle 2002). Hitch are not aggressive swimmers and can be barred from habitat by small dams and other structures (Moyle 2002).

Moyle (2002) lists the probable factors influencing the declining status of hitch in the North Coast Region to include:

- ✓ Loss of adequate spawning flows in spring months (because of dams and diversions);
- ✓ Loss of summer rearing and holding habitat;
- ✓ Pollution; and,
- ✓ Predation by nonnative fishes.

No information could be found with respect to the DO requirements of hitch. But, because of their wide temperature and salinity tolerances, staff assumes that DO thresholds also range widely making hitch far less sensitive to DO than salmonids.

IV.3.8 Tidewater Goby

The tidewater goby (*Eucyclogobius newberryi*) is endemic to California, found in lagoons of coastal streams throughout the North Coast Region up to the Smith River (Moyle 2002). Tidewater gobies prefer well-oxygenated, brackish, cool waters with salinities less than 10 ppt (Moyle 2002). They are generally absent from lagoons that stagnate or stratify (Moyle 2002). Tidewater gobies live about 1 year with reproduction occurring throughout the year, though little spawning occurs from December through March (Moyle 2002). The male creates a vertical burrow in which fertile eggs are laid (Moyle 2002). Male tidewater gobies prefer relatively unconsolidated, clean, coarse sand and begin digging in April or May after lagoons close to the ocean (Swift et al. 1989; Swenson 1995 as cited by USFS 2007). The male guards the embryos for 9-11 days, after which the larvae emerge from the burrow and join the benthos (Moyle 2002). Juvenile/adults fish prefer sand, mud, gravel and silt, particularly is association with submerged vegetation for cover from predators (Stillwater Sciences 2006). Tidewater gobies are found at DO concentrations ranging from 0.2 mg/L to 15.5 mg/L (Tetra Tech Inc. 2000, Irwin and Soltz 1984, and Chamberlain 2006 as cited by Stillwater Sciences 2006) with some evidence that higher densities are found between 2-4 mg/L DO (Tetra Tech Inc. 2000 as cited by Stillwater Sciences 2006).

Moyle (2002) notes the effects of upstream logging on tidewater goby habitat, including increased sedimentation and increased severity of high-flow events. He also notes that where estuaries have been permanently breached with jetties, tidewater gobies are absent.

Staff concludes that DO objectives designed to protect salmonids will also protect tidewater gobies.

IV.4 Summary

In summary, there a number of native fish species of the North Coast Region that are at risk of extinction, including species of: salmonids, lamprey, sucker, sturgeon, hitch, smelt, perch, and goby. These fishes occupy a variety of freshwater and estuarine habitats, some of them overlapping with other native species. The life cycles vary considerably with some species spending a majority of their lives in freshwater and others in the ocean. Yet, the information staff has been able to gather on the DO and/or other water quality requirements of each of the species of interest suggests that DO objectives designed to protect salmonids likely will protect the other native species, as well, even for those species with extended larval stages such as the lamprey. This brief assessment is intended only to confirm that the general bias towards salmonids in the establishing of water quality objectives is, at least for DO, warranted.

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CHAPTER V.
ASSESSMENT OF EXISTING DO OBJECTIVES AND RECOMMENDATIONS

The purpose of this chapter is to assess the continued appropriateness of the existing DO objectives and determine what revisions and/or updates are required to ensure full protection of water quality and beneficial uses. To this end, staff has conducted the following analyses:

1. Compared the existing life cycle DO objectives to USEPA guidance on the development of ambient water quality criteria for DO and the other scientific literature as presented in Chapter IV; and,
2. Evaluated 4 lines of evidence regarding the appropriateness of the existing Table 3-1 DO objectives as representations of background, including the results of the Klamath River TMDL for DO.

V.1 Assessment of Life Cycle DO Objectives

As described in Chapter II, the life cycle DO objectives are given in the Basin Plan as daily minimum objectives specific to the beneficial uses they are each designed to protect. For example, in waterbodies designated as WARM, MAR, or SAL, an ambient water quality objective of 5.0 mg/L is applied. In waterbodies designated as COLD, an ambient water quality objective of 6.0 mg/L is applied. And, in waterbodies designated as SPWN, an ambient water quality objective of 7.0 mg/L is applied, except during critical periods of spawning and egg incubation when an ambient water quality objective of 9.0 mg/L is applied.

Staff compared the freshwater life cycle DO objectives (i.e., for WARM, COLD, and SPWN) as they are currently given in the Basin Plan to USEPA guidance on the development of freshwater ambient water quality criteria for DO (USEPA 1986). Because USEPA's freshwater guidance is over 20 years old, staff further compared the COLD and SPWN objectives to a survey of scientific literature conducted in-house in 2005 (Carter 2005). Carter (2005) surveyed the effects of DO on salmonids by life stage. It is incorporated here by reference and included in Appendix E and has been previously peered reviewed. It is summarized in Chapter IV along with other scientific literature regarding the life cycle requirements of salmonids and other native North Coast fish species.

Staff compared the saltwater life cycle DO objectives (i.e., for MAR and SAL) as they are currently given in the Basin Plan to USEPA guidance on the development of saltwater ambient water quality criteria for DO (USEPA 2000). The saltwater guidance was developed for the Atlantic coast from Cape Cod to Cape Hatteras, only. As such staff referred to the Southern California Coastal Water Research Project's (SCCWRP) assessment of USEPA (2000) for insight on the application of USEPA (2000) to Pacific waters (SCCWRP 2003). Though no DO objective for the protection of the EST[6]

[6] The estuarine habitat (EST) beneficial use includes uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds).

beneficial use is currently given in the Basin Plan, staff considered USEPA (2000) and SCCWRP (2003) with respect to estuarine protection, as well.

V.1.1 Comparison of Freshwater Life Cycle DO Objectives to USEPA (1986)

USEPA (1986) reviewed the scientific literature for the effects of various DO concentrations on mortality, growth, reproduction, early life stages, behavior, and swimming ability of both salmonid and non-salmonid fish species. It further reviewed the effects of various DO concentrations on macroinvertebrates, though concluded that DO suitable to support salmonids would adequately protect macroinvertebrates, as well. USEPA (1986) is incorporated by reference as a primary scientific source and is included as Appendix ??

Largely based on growth and survival data, generalization of response curve shape and assumed applicability of laboratory responses to natural populations, USEPA (1986) developed four levels of risk as given in Table 1: no, slight, moderate, and severe production impairment.

Table 1: USEPA's (1986) DO concentrations (mg/L) equivalent to qualitative levels of effect

	Salmonid waters		Nonsalmonid waters		Invertebrates
	Embryo and larval stages*	Other life stages	Early life stages	Other life stages	
No production impairment	11 (8)	8	6.5	6	8
Slight production impairment	9 (6)	6	5.5	5	5
Moderate production impairment	8 (5)	5	5	4	
Severe production impairment	7 (4)	4	4.5	3.5	
Limit to avoid acute mortality	6 (3)	3	4	3	4

*Values within parentheses represent the DO concentration required within the intragravel environment. Values without parentheses represent the DO concentration estimated as necessary to achieve the required intragravel DO.

USEPA (1986) recommended national DO criteria. But, it provided guidance for the development of local criteria, as well. In the development of local criteria, USEPA (1986) recommended that "if slight production impairment or a small but undefinable risk of moderate production impairment is unacceptable" then continuous exposure conditions should use the *no production impairment* values developed from the scientific literature as means and the *slight production impairment* values as minima. Staff concludes that slight or moderate impairment is unacceptable in North Coast waterbodies because of the risk of extinction facing several native fish species. USEPA recommendations for each life cycle stage, described below, are based on this premise.

USEPA (1986) also recommended the use of a 7-day averaging period for embryonic, larval, and early life stages because of the sensitivity of these life stages. USEPA (1986) further said that "other life stages can probably be adequately protected by 30-day averages." Staff recommends the use of a 7-day averaging period for all life stages because of the risk of extinction facing several native fish species. The discussion below is based on this premise, as well.

V.1.1.1 Coldwater Criteria for Early Life Stages (SPWN)

As given in Table 1, USEPA (1986) recommended for sensitive coldwater populations for which slight or no production impairment is acceptable, daily minimum DO conditions for early life stages based on slight production impairment values:

- ✓ ≥6.0 mg/L in the intragravel environment and
- ✓ ≥9.0 mg/L in the water column.

USEPA (1986) further recommended 7-day average DO conditions for early life stages based on no production impairment values:

- ✓ ≥8.0 mg/L in the intragravel environment and
- ✓ ≥11.0 mg/L in the water column.

Daily Minimum Requirement

The Basin Plan gives as the SPWN life cycle requirement a daily minimum DO condition ≥ 9.0 mg/L in the water column. The Basin Plan does not include a 7-day average limit; nor, are there requirements specific to the intragravel environment.

The 9.0 mg/L daily minimum SPWN requirement given in the Basin Plan applies to the period of "critical spawning and egg incubation." The calendar dates during which "critical spawning and egg incubation" occur are not included in the Basin Plan. Further, this period as defined does not include the time after egg incubation when the yolk-sac fry or alevin still reside in the intragravel environment. For the period of yolk-sac absorption—and the rest of the year—the Basin Plan includes a daily minimum SPWN requirement of 7.0 mg/L.

USEPA (1986) arrived at the 9.0 mg/L daily minimum DO requirement in the water column based on the findings of Koski (1965) in which the minimum intragravel concentrations averaged for 3 small, unlogged, forested watersheds was 3.0 mg/L below the overlying water. Thus, to ensure sensitive early life stages a minimum of 6.0 mg/L DO in the intragravel environment, the overlying water column must be at least 9.0 mg/L. A SPWN DO requirement of 7.0 mg/L during yolk-sac absorption and prior to fry emergence may result in intragravel DO conditions as low as 4.0 mg/L as a daily minimum. WDOE (2002) as cited by Carter (2005) found that alevin avoided areas where DO was 4-6 mg/L.

To ensure adequate protection of early life stages in the intragravel environment, staff recommends eliminating the 7.0 mg/L daily minimum SPWN requirement as under protective. Staff further recommends expanding the period of time in which the 9.0 mg/L daily minimum SPWN requirement is applied to include all early life stages prior to emergence.

7-day Average Requirement
The existing DO objectives do not include a 7-day average objective to protect the processes spawning and early development from DO stress due to multiple days of depressed DO. USEPA (1986) recommends criteria that include average limitations and Regional Water Board staff concur. Because of the risk of extinction facing several native fish species in the North Coast Region, staff recommends a 7-day average requirement based on the "no production impairment" value given in Table 1. This is a moving 7-day average of 11.0 mg/L DO in the water column based on seven consecutive daily averages. The water column DO objective for coldwater spawning is based on an estimate of the DO required in the water column to ensure adequate DO in the intragravel environment where developing eggs and alevin reside.

Intragravel Requirement
As described in Chapter III, common DO monitoring tools include the 1) Winkler titration conducted in the field using a grab sample and 2) a datasonde which automatically collect continuous data over 24-hours or longer. Common tools and methods of intragravel DO field sampling have not yet been fully developed or broadly used (Fadness 2009). Further, monitoring the intragravel environment during spawning, egg incubation, and early development risks the possibility of 1) direct harm to eggs and/or alevin and/or 2) an unfavorable alteration of the redd environment.

As such, staff does not recommend adding intragravel DO requirements to the Basin Plan at this time. Instead, staff recommends water column criteria that are 3 mg/L greater than the DO concentration required in the intragravel environment to protect eggs and pre-emergence life stages. DO conditions in the intragravel environment must be an average of 8.0 mg/L to ensure no production impairment of threatened and endangered species. As described by USEPA (1986), 11.0 mg/L DO in the water column is necessary to ensure an average of 8.0 mg/L DO in the intragravel environment.

Location and Timing of SPWN
The current objectives for SPWN are developed specifically for the protection of salmonids. The location and timing of spawning is different for each of the native species of fishes at risk of extinction in the North Coast Region. Yet, with respect to DO requirements, it appears that objectives developed to protect salmonids will be reasonably protective of the other species, as well, including early life stages. This is not only because of the greater salmonid sensitivity to DO conditions then many other native species of fish. But, it is also because most of the North Coast Region is designated as providing the SPWN beneficial use based on the historic and/or existing use of North Coast estuaries and rivers by salmonids. Because of the widespread use of North Coast streams by salmonids, other fish species with geographically narrower freshwater ranges will benefit from the broad application of the SPWN objective.

According to Moyle (2002), salmonid spawning and incubation generally occurs in the North Coast Region from mid-September to early June. The Hoopa Valley Tribe has established in its water quality control plan a spawning and incubation period of

September 15 through June 4 based on studies in the Trinity River. This period reasonably coincides with expected spawning and incubation throughout the Region.

For the purpose of DO, staff recommends that objectives designed to protect the SPWN beneficial use be applied in all waterbodies listed for SPWN and during the period of the year in which salmonid spawning and incubation is or has historically occurred, estimated as September 15 through June 4.

V.1.1.2 Coldwater Criteria for Other Life Stages (COLD)
As given in Table 1, USEPA (1986) recommended for sensitive populations of juvenile and adult coldwater fish for which little or no production impairment is acceptable, daily minimum DO conditions ≥6.0 mg/L in the water column. USEPA (1986) further recommended 7- or 30-day average DO conditions ≥8.0 mg/L in the water column.

Daily Minimum Requirement
The Basin Plan gives as the COLD life cycle requirement a daily minimum DO condition ≥ 6.0 mg/L in the water column. This is in accordance with USEPA (1986) guidance and the findings of Carter (2005), as described in Chapter IV. As such, staff recommends no changes to this objective.

7-day Average Requirement
The Basin Plan does not currently include a 7- or 30-day average limit. The absence of an average DO requirement could result in multiple days in which the daily minimum DO objective is met and therefore compliance is achieved. Yet, water quality conditions are stressful to aquatic organisms due to a regularity of exposure to DO conditions that allows for slight production impairment. Because of the number of species at risk of extinction in the North Coast Region, Staff recommends a 7-day average as more protective than a 30-day average. Staff proposes the addition to the Basin Plan of a 7-day average of the daily minimums ≥8.0 mg/L. This is in accordance with USEPA (1986), as well as the findings of Carter (2005). This is a moving 7-day average of DO in the water column based on 7 consecutive daily minimums.

V.1.1.3 Warm Water Criteria (WARM)
The Basin Plan currently assigns a daily minimum DO concentration of 5.0 mg/L as the life cycle DO objective for the protection of WARM. This is implemented as an instantaneous minimum. There is no accompanying average limit to protect against the chronic effects of DO stress. Further, there is no SPWN DO objective specifically developed to protect early life stages of warm water species.

The WARM DO objective applies in only two waterbodies in the North Coast Region: the Bray Hydrologic Subarea in the Butte Valley Hydrologic Area and Tule Lake Hydrologic Subarea of the Lost River Hydrologic Area. Both are contained within the Klamath River watershed. With the exception of these two waterbodies, all the other North Coast waterbodies designated as WARM are also designated as COLD. As the DO objectives associated with the protection of COLD are more stringent than those associated with the protection of WARM, the COLD DO objectives apply in all the other

North Coast basins. Only in those waterbodies for which a Use Attainability Analysis is successfully conducted in the future will the application of the WARM DO objective ever expand.

The Bray Hydrologic Subarea is in the Butte Valley Hydrologic Area, a closed basin approximately 18 miles long from north to south and with a maximum width of 13 miles. The Butte Valley floor is an ancestral lake bed that encompasses an area of about 130 square miles. Volcanic rocks surround the valley and underlie it at depths of about 400 to 1,500 feet. Streams drain into the valley from the west, and the water either infiltrates permeable deposits or flows into Meiss Lake, which is a small remnant of the large lake that once filled the valley. Discharge from the valley is by subsurface flow through fractured volcanic rocks to adjacent basins (USGS 1995).

The Tule Lake Hydrologic Subarea is in the Lost River Hydrologic Area. Much of the native hydrology of the basin has been modified for the purpose of agricultural irrigation and the management of wildlife preserves. Summer flows in Tule Lake are dominated by agricultural return flows. As described in Chapter IV, two species of endangered suckers reside in the Lost River Hydrologic Area.

USEPA (1986) recommended 5.5 mg/L DO as a daily minimum and 6.5 mg/L as a 7- or 30-day average to protect against production impairment of early life stages of warm water fish. It further recommended 5.0 mg/L DO as a daily minimum and 6.0 mg/L as a 7- or 30-day to protect against production impairment of other life stages of warm water fish (USEPA 1986).

With respect to the general population of warm water fish, the existing 5.0 mg/L DO objective as a daily minimum appears to adequately protect against significant production impairment. The addition of a 7-day or 30-day average of 6.0 mg/L would further protect against the chronic effects of DO stress. As described above, USEPA (1986) recommends a 7-day average to protect sensitive species or life stages. Staff recommends the application of 6.0 mg/L as a 7-day moving average of the daily minimum to ensure maximum protection, due to the presence of the endangered suckers in the Lost River Hydrologic Area.

With respect to the early life stages of warm water fish, staff has considered several lines of thought in its attempt to determine an appropriate approach to the protection of the early life stages of warm water fish. These include: 1) consideration of the structure of beneficial uses as given in the Basin Plan; 2) the range of applicability of the WARM DO objective; and 3) the range of accuracy of the datasonde for the measurement of DO.

The Basin Plan does not currently distinguish between SPWN objectives designed to protect coldwater species and those necessary to protect warm water species. For this purpose, the Basin Plan might ideally include a SPWN (cold) and a SPWN (warm) to adequately make the distinction. At present, only a SPWN designation is given and is designed to protect coldwater organisms. In the absence of a revision to the beneficial uses, the Basin Plan might otherwise include a SPWN DO objective for the protection of warm water species with an explanation in the Basin Plan as to its specific applicability to streams designated as WARM, only.

The fish species most affected by the designation of WARM and SPWN to protect warm water fishes, are the endangered suckers of the Lost River Hydrologic Subarea. This is because there are only two subareas of the Region in which WARM DO objectives apply, the Lost River Hydrologic Subarea being one of them. As described in Chapter IV, Woodhouse et al. (2004) identified a threshold of greater than 2.3 mg/L DO for the protection of endangered suckers, based on an LC_{50} for shortnose sucker larvae. This is in essence an early life cycle criteria and is less stringent than the 5.5 mg/L DO recommended by USEPA (1986).

The Hydrolab datasonde is reported to have an accuracy of ±0.2 mg/L for measurements < 20 mg/L DO. The difference between 5.0 and 5.5 mg/L as a daily minimum and 6.0 and 6.5 mg/L as a 7-day mean is not large. But, it is a difference which standard monitoring equipment is capable of distinguishing.

Staff concludes in the weighing of these pieces of information that the early life stages of warm water fish in the Lost River Hydrologic Subarea and Bray Hydrologic Subarea are adequately protected with a WARM DO objective of 5.0 mg/L as a daily minimum and 6.0 mg/L as a 7-day mean. The addition of a separate SPWN objective for the protection of warm water species appears unwarranted at this time. Staff recommend that in the event that any waterbodies of the North Coast are dedesignated for COLD and the WARM objectives as recommended here no longer appear to protect early life stages of the warm water species of concern in those basins, then consideration of a subcategory of the SPWN beneficial use for the protection of warm water species should be given. Further, DO objectives for the protection of early life stages of warm water fish should be developed under this new subcategory.

V.1.1.4 MAR, SAL, and EST

The Basin Plan currently assigns a daily minimum DO concentration of 5.0 mg/L as the life cycle DO objective for the protection of MAR and SAL. It does not include a life cycle DO objective for the protection of EST; though, all of the waterbodies designated as EST are also designated as COLD and SPWN and thus the life cycle DO objectives for these beneficial uses apply. There are 13 individually named hydrologic areas/subareas for which MAR is an existing designated use, including:

- Smith River Plain Hydrologic Subarea,
- Crescent City Harbor,
- Klamath Glen Hydrologic Subarea,
- Orick Hydrologic Subarea,
- Big Lagoon Hydrologic Area,
- Little River Hydrologic Area (in the Trinidad Hydrologic Unit),
- Humboldt Bay,
- Bodega Bay Hydrologic Area,
- Estero Americano Hydrologic Area,

- Estero de San Antonio Hydrologic Area,
- Ocean waters,
- Bays, and
- Estuaries.

There are also 4 hydrologic areas/subareas for which MAR is a potential designated use, including: Blue Lake Hydrologic Area, Ferndale Hydrologic Area, minor coastal streams, and saline wetlands. With the exception of ocean waters, all the hydrologic areas/subareas designated as MAR are stream reaches in which freshwater and saline water influences are present.

Only the Russian Gulch Hydrologic Area is listed as providing the SAL beneficial use. But, staff believes this to be a typographical error; and, it will be corrected through another basin planning amendment process. Saline wetlands are designated as potentially providing the SAL beneficial use.

The Basin Plan also requires for coastal waters that DO concentrations not at any time be depressed more than 10% from that which occurs naturally. This applies to saline waters only, and is derived from the State's Ocean Plan (Resolution No. 90-27) as revised in 1990 and included in Table 3-1 of the Basin Plan. Also included in Table 3-1 are site-specific DO objectives of 6.0 mg/L as a daily minimum for Bodega Bay and Humboldt Bay.

USEPA does not have specific criteria recommendations for Pacific Coast saltwater environments. But, USEPA (2000) recommends criteria for the saltwater environments of the Atlantic Coast which are useful for comparison. USEPA (2000) recommends 2.3 mg/L DO as the criterion minimum concentration (CMC) to ensure juvenile and adult survival, applied as a 1-hour average. It also recommends 4.8 mg/L DO as the criterion continuous concentration (CCC) to ensure no negative effects on growth, applied as a 4-day average. From this, USEPA (2003) as cited by SCCWRP (2003) has developed criteria specific to the Chesapeake Bay. SCCWRP (2003) considered both USEPA (2000) and USEPA (2003) in its contemplation of DO criteria for Newport Bay in southern California. The work of USEPA (2000), USEPA (2003) and SCCWRP (2003) apply to stream reaches with both freshwater and saline water influences.

In its comparison of USEPA (2000) and USEPA (2003) to the conditions in Newport Bay, SCCWRP (2003) made the following observations:

- Phytoplankton are the dominant primary producers in the Chesapeake Bay and in many other systems where DO concentrations have been studied (Cloern 2001 as cited by SCCWRP 2003). Macroalgae, on the other hand, are the primary producers in the Newport Bay system. The relationships among nutrient loading, primary production, and DO availability must be better understood for macroalgae systems prior to determining the applicability of USEPA (2000) and USEPA (2003) to west coast systems.

- West coast estuaries differ from those of the east coast in terms of the physical structure of the water column. In river-dominated estuaries such as the Chesapeake and many other East and Gulf Coast systems with significant year round freshwater flow, the interface between the warm fresh water and the cold, denser seawater is a major contributing factor to vertical stratification while these phenomena may be limited in west coast systems with minor freshwater summer flows. The difference in flows also results in differences in average channel depths and widths, as well as other physical estuarine characteristics.

SCCWRP (2003) also observed that "low DO availability often occurs in conjunction with other anthropogenic stressors that accompany increased development. These additional factors, which include increased pathogen prevalence, fishing pressure, sediment loads, increase and altered freshwater inputs, and hydrodynamic modifications (Breitburg 2002 as cited by SCCWRP 2003), may interact synergistically with hypoxia to negatively impact aquatic resources."

With these things in mind, staff recommends the retention of the existing 5.0 mg/L DO objective for MAR and SAL and 6.0 mg/L DO objective for Bodega Bay and Humboldt Bay as more than adequate protection of these beneficial uses and locations. This is based on the fact that direct application of USEPA (2000) and USEPA (2003) is not yet demonstrated for west coast systems; however, USEPA (2000) results in criteria recommendations less stringent than 5.0 mg/L and 6.0 mg/L as daily minima.

In addition, staff recommends the future study of North Coast bays and estuaries, with consideration of the variety of factors that combine from upstream activities to impact the estuarine environment, including the potential development of a plan specifically designed to protect the resources of North Coast bays and estuaries. Within this context, staff proposes the potential for revision and expansion of the MAR and SAL DO objectives (as well as other related objectives) and the development of a numeric EST DO objective (as well as other related objectives), as new data is developed and insights garnered.

In the mean time, staff recommends the adoption of a narrative DO objective for the protection of the Region's bays and estuaries which is modeled after the one contained in the Santa Ana Regional Water Board's Basin Plan, protecting among other resources, Newport Bay. That narrative objective reads: "The dissolved oxygen content of enclosed bays and estuaries shall not be depressed to levels that adversely affect beneficial uses as a result of controllable water quality factors." Staff recommends this narrative objective as a tool for ensuring that the study of individual bays or estuaries can lead to the appropriate protections until such time as the revision of the numeric objectives is proven necessary and is accomplished.

V.1.2 Summary of Staff Recommendations for Revision of Life Cycle Objectives

1. *SPWN*: To ensure adequate protection of early life stages in the intragravel environment, staff recommends eliminating the 7.0 mg/L daily minimum SPWN requirement as under protective. Staff further recommends expanding the period

of time in which the 9.0 mg/L daily minimum SPWN requirement is applied to include all early life stages prior to emergence.

2. *SPWN:* Because of the risk of extinction facing several native fish species in the North Coast Region, staff recommends a 7-day average requirement based on the "no production impairment" value given in Table 1. This is a moving 7-day average of 11.0 mg/L DO in the water column based on seven consecutive daily averages.
3. *SPWN:* Staff does not recommend adding intragravel DO requirements to the Basin Plan at this time. Instead, staff recommends water column criteria that are 3 mg/L greater than the DO concentration required in the intragravel environment to protect eggs and pre-emergence life stages, as described above.
4. *SPWN:* Staff recommends that objectives designed to protect the SPWN beneficial use be applied in all waterbodies listed for SPWN and during the period of the year in which salmonid spawning and incubation is or has historically occurred, estimated as September 15 through June 4.
5. *COLD:* Staff recommends no changes to the existing daily minimum DO objective for COLD.
6. *COLD:* Staff recommends the addition to the Basin Plan of a 7-day average of the daily minimums ≥8.0 mg/L. This is a moving 7-day average of DO in the water column based on 7 consecutive daily minimums.
7. *WARM:* Staff recommends the addition to the Basin Plan of 6.0 mg/L as a 7-day moving average of the daily minimum.
8. *MAR, SAL, and EST:* Staff recommends the retention of the existing 5.0 mg/L DO objective for MAR and SAL and 6.0 mg/L DO objective for Bodega Bay and Humboldt Bay as adequate protection of these beneficial uses and locations.
9. *MAR, SAL and EST:* Staff recommends that the Board consider in the next triennial review prioritizing the future study of North Coast bays and estuaries, with consideration of the variety of factors that combine from upstream activities to impact the estuarine environment. Staff further recommends that the outcome of this study include the development of a plan specifically designed to protect the resources of North Coast bays and estuaries. Within this context, staff proposes the potential for revision and expansion of the MAR and SAL DO objectives (as well as other related objectives) and the development of a numeric EST DO objective (as well as other related objectives).
10. *MAR, SAL and EST:* Staff recommends the adoption of a narrative DO objective for the protection of the Region's bays and estuaries as follows: "The dissolved oxygen content of enclosed bays and estuaries shall not be depressed to levels that adversely affect beneficial uses as a result of controllable water quality factors."

V.2 Assessment of Background DO Objectives

The framework of the Basin Plan is based on the logic that protection of water quality in the North Coast is best provided by prohibiting the point source discharge of waste. Some exceptions to this framework are included in the Basin Plan for the Lost River and for the Mad, Eel, and Russian rivers from October 1 through May 14. In all other streams and all other times of the year, the point source discharge of waste is prohibited.

The DO objectives included in the Basin Plan compliment this framework by requiring that for all the streams named in Table 3-1 of the Basin Plan, background ambient water quality conditions for DO be maintained. To accomplish this end, the Table 3-1 DO objectives are established at what was understood in 1975 to be background levels. For those waterbodies not named in Table 3-1 of the Basin Plan, the alternative protection strategy was to establish DO objectives designed to protect aquatic fish and wildlife resources (i.e., life cycle DO objectives).

Staff has assessed the Table 3-1 DO objectives to determine if they are established at levels understood today to represent background conditions. The assessment highlights several lines of evidence indicating that the Table 3-1 DO objectives do not depict background conditions and require updating.

V.2.1 Table 3-1 DO Objectives

The Table 3-1 DO objectives were developed for individually named waterbodies throughout the Region and include 58 separate entries. As described in Chapter II, they are based on background conditions as measured by extensive regional sampling in the 1950s and 1960s collected by a range of partners including federal, state and local agencies. The Department of Water Resources published the data in annual bulletins beginning with data from 1951. Generally, the data are monthly grab samples that were collected during day light hours and analyzed in the field using the Winkler titration method.

As a result of this sampling, the majority of the listed waterbodies (71%) were assigned a background DO objective of 7.0 mg/L as a daily minimum. This includes all of the listed waterbodies in the North Coastal Basin (100%) and 58% of the listed waterbodies in the Klamath River Basin. Exceptions to this norm are listed in Table 2 below so as to indicate the range of background DO objectives contained in the Basin Plan.

V.2.2 Grab sampling versus continuous monitoring

The first line of evidence that the background DO objectives require updating is based on a general observation about the relationship between grab samples and the diurnal fluctuation of DO in many freshwater systems. As described in Chapter III, DO fluctuates temporally and spatially as a result of numerous factors, including both natural and anthropogenic factors. A grab sample provides only a snapshot of the DO condition at that location at a given moment in time.

Table 2: Background DO Objectives from Table 3-1 of the Basin Plan

Hydrologic Area	Waterbody	DO Objective (mg/L)
Lost River HA	Clear Lake Reservoir and Upper Lost River	5.0
	Lower Lost River	5.0
	Tule Lake	5.0
	Lower Klamath Lake	5.0
Shasta Valley HA	Lake Shastina	6.0
Salmon River HA	All streams	9.0
Middle Klamath River HA	Klamath River below Iron Gate Dam	8.0
Lower Trinity River HA	Trinity River	8.0
	Other streams	9.0
Lower Klamath River HA	Klamath River	8.0
	Other streams	8.0
Ilinois River HA	All streams	8.0
Winchuck River HU	All streams	8.0
Smith River HU	Smith River-Main Forks	8.0
Smith River Plain HSA	Smith River	8.0
Eureka Plain HU	Humboldt Bay	6.0
Russian River HU	Bodega Bay	6.0
All other Hydrologic Areas	Waterbodies listed in Table 3-1	7.0

For the period of time when ambient water quality data was routinely collected during daylight hours by grab sample, the results could reasonably be compared to the Table 3-1 objectives for compliance and other purposes. This is because the Table 3-1 objectives were developed from data collected in the same manner. However, Regional Water Board staff more recently began collecting ambient DO data using continuous monitoring probes (datasondes). These datasondes collect data at a preset interval over the course of a day or longer and electronically record the results. The outcome is a continuous DO dataset that shows the pattern and range of DO fluctuation over the course of 24 hours, including the minimum DO condition generally observed during the night. The night time, minimum DO condition had previously been excluded from most DO datasets, including those that were used to calculate the Table 3-1 DO objectives. Comparison of the night time minimum DO condition as measured by a continuous monitoring probe to the Table 3-1 objectives identified as daily minimums can be misleading.

A cursory review of DWR's hydrologic data reports from the 1950s and 1960s indicates that the DO data often indicated fully saturated or supersaturated conditions during the day. This suggests that night time conditions were often subsaturated. To illustrate this point, Summers and Engle (1993), as cited by SCCWRP (2003), found that single, daytime instantaneous measures of DO detected hypoxia only 20% of the time that it was known to occur based on 31 days of continuous sampling in the Gulf of Mexico. While this statistic is unlikely to apply to freshwater streams in the North Coast, it nonetheless illustrates the disconnect between day time measurements and the detection of low DO.

V.2.3 Historic landuse

The second line of evidence that the background DO objectives require updating is based on a general observation regarding the history of landuse in the North Coast Region prior to and including the period of the 1950s and 1960s. Commercial scale mining and logging operations began in areas throughout California, including the North Coast Region in the mid- to late 1800s. This was followed by dam building and agricultural enterprises, as well as urban development. By the 1950s and 1960s, areas of the North Coast Region were undergoing their second wave of timber cutting; by that time with the use of tractors and other heavy equipment which left a significant foot print on the landscape and downstream watercourses. Though the point source discharge of waste from urban development has been very localized in the North Coast Region, other direct effects on water quality from stream channel modification, road building, dam building, and gravel mining, as examples, have been felt in the North Coast Region for over a century. Further, the indirect effects known as nonpoint source pollution emanating from agricultural runoff, wetland reclamation, sedimentation, water diversions, and the like have also been felt in the North Coast for over a century.

As depicted in Figure 1 (CADDIS conceptual model for DO), these activities affect the availability of DO in aquatic systems. Thus, by the 1950s and 1960s, it is likely that DO was already altered from its natural state and measurements made during this time probably did not represent true background conditions in all locations.

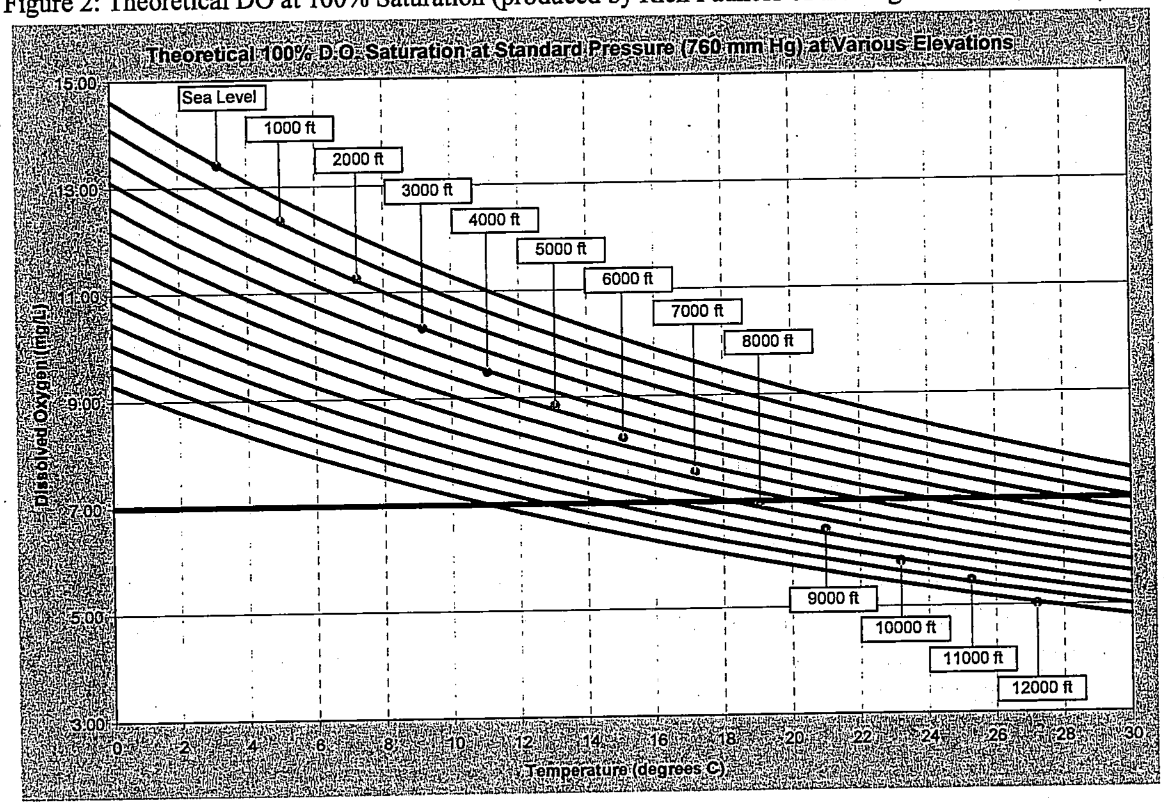
V.2.4 DO at saturation

The third line of evidence that the background DO objectives require updating is based on an assessment of the theoretical DO concentrations possible within North Coast waterbodies at 100% and 85% DO saturation. Staff calculated the theoretical DO concentrations under varying temperatures and elevations to produce Figure 2 (100% saturation) and Figure 3 (85% saturation). Figure 3 indicates staff's rough estimate of the minimum DO concentrations that occur as a result of the natural fluctuation in DO concentrations resulting from photosynthesis, respiration, turbulence, and biological and chemical oxidation. Staff assumed this to be reasonably represented by a DO saturation of 85%. Figure 2 indicates the minimum DO concentrations possible in the absence of these moderating factors, as represented by 100% saturation. The calculations were made using standard pressure (760 mm Hg) and assuming freshwater conditions.

For the purpose of assessment, staff identified a temperature of 22 °C as reasonably representing the maximum temperature supporting salmonids. At this temperature, Figure 2 indicates that those locations greater than 7000 feet in elevation do not achieve a minimum DO concentration of 7.0 mg/L under standard pressure. As a point of comparison, most of the watersheds in the North Coast Region are less than 6000 feet in elevation, with the exception of locations within the Klamath River and Trinity River basins. But, at 85% saturation and 22 °C, Figure 3 indicates that locations greater than 3000 feet do not achieve a minimum of 7.0 mg/L. This suggests that at standard pressure the freshwater locations in the Humboldt Bay watersheds and the Gualala-Salmon-Bodega Bay watersheds can reasonably be expected to achieve a minimum DO concentration of 7.0 mg/L, even when stream temperatures are high. But, for those locations throughout the Region that exceed 3000 feet, experience a diurnal fluctuation in DO, and experience periodic high stream temperatures, a minimum DO concentration of 7.0 mg/L may not consistently be possible, particularly during summer nights.

As a point of comparison, Blodgett (1971) reports for the period of 1951-1968 monthly mean temperatures in the Region that are ≤10 °C, suggesting that temperatures are generally low enough to ensure background DO conditions ≤7.0 mg/L. But, the average *maximum* temperature for this period is 25 °C with a range of 16-34 °C. This indicates that background DO conditions ≤7.0 mg/L are periodically impossible. The period 1951-1968 is the same period from which DO data was collected and analyzed for the purpose of developing background DO objectives for the original Basin Plan. As such, staff conclude that even at the time of their development, the background DO objectives in Table 3-1 were not consistently achievable during summer nights at higher elevations.

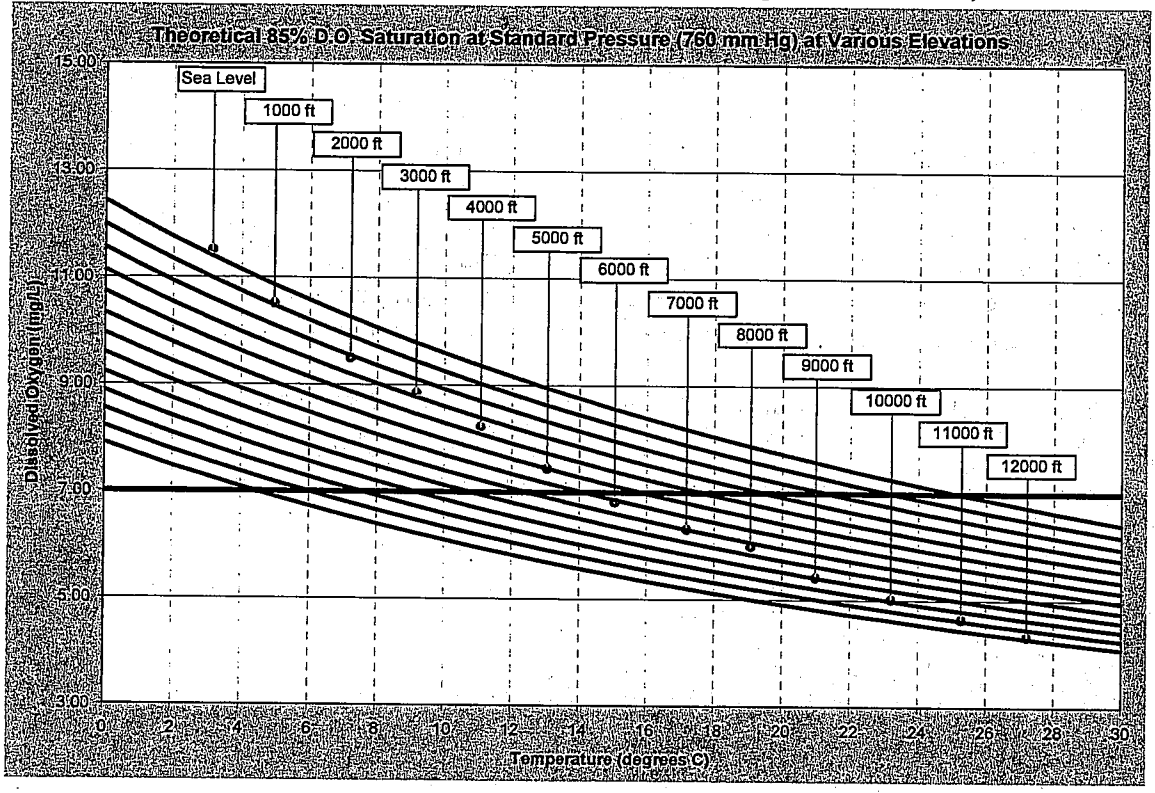
Figure 2: Theoretical DO at 100% Saturation (produced by Rich Fadness of the Regional Water Board)



V.2.5 Klamath River TMDL for DO

The fourth line of evidence that the background DO objectives require updating is based on the modeling conducted for the Klamath River Total Maximum Daily Load (TMDL) for DO. The Klamath River has been listed on the 303(d) list as impaired for DO, as well as other parameters. Water quality model simulations of natural baseline conditions in the Klamath River, detailed below, estimated minimum DO conditions below the existing and proposed life cycle DO objectives and below the existing background DO objectives for the river.

Figure 3: Theoretical DO at 85% (produced by Rich Fadness of the Regional Water Board)



V.2.5.1 Klamath River Water Quality Modeling

To support TMDL development for the Klamath River system, the need for an integrated receiving water hydrodynamic and water quality modeling system was identified. A model for the Klamath River had already been developed by PacifiCorp to support studies for the Federal Energy Regulatory Commission hydropower relicensing process (PacifiCorp 2005) when this project commenced. The version of the model available in 2004 is hereafter referred to as the *PacifiCorp Model*. The Regional Water Board, Oregon Department of Environmental Quality (ODEQ), and USEPA determined that this existing *PacifiCorp Model* would provide the optimal basis, after making some enhancements, for TMDL model development. The *PacifiCorp Model* uses hydrodynamic and water quality models with a proven track record in the environmental arena and has already been reviewed by most stakeholders in the Klamath River watershed. Additionally, it can be directly compared to ODEQ, Regional Water Board and Tribal water quality criteria.

Description of the Model

The original *PacifiCorp Model* consisted of Resource Management Associates (RMA) RMA-2 and RMA-11 models and the U.S. Army Corps of Engineers' CE-QUAL-W2 model. The RMA-2 and RMA-11 models were applied for Link River (which is the stretch of the Klamath River from Upper Klamath Lake to Keno Dam), Keno Dam to J.C. Boyle Reservoir, Bypass/Full Flow Reach, and Iron Gate Dam to Turwar (See Figures 4 and 5). RMA-2 simulates hydrodynamics while RMA-11 represents water quality processes. The CE-QUAL-W2 model was applied for Lake Ewauna-Keno Dam, J.C. Boyle Reservoir, Copco Reservoir, and Iron Gate Reservoir. CE-QUAL-W2 is a two-dimensional, longitudinal/vertical (laterally averaged), hydrodynamic and water quality model (Cole et al. 2003). For the purposes of TMDL development, enhancements to the RMA/CE-QUAL-W2 portions of the PacifiCorp model were made in the following areas: BOD/organic matter (OM) unification, algae representation in Lake Ewauna, Monod-type continuous Sediment Oxygen Demand (SOD) and OM decay, pH simulation in RMA, OM-dependent light extinction simulation in RMA, reaeration formulations, and dynamic OM partitioning.

Since the estuarine portion of the Klamath River (Turwar to the Pacific Ocean) was not included in the original *PacifiCorp Model*, one of the first updates made was to include an estuarine model. From a review of available data for the estuary, it was apparent that hydrodynamics and water quality within the estuary are highly variable spatially and temporally and are greatly influenced by time of year, river flow, tidal cycle, and location of the estuary mouth (which changes due to sand bar movement). Additionally, transect temperature and salinity data in the lower estuary showed significant lateral variability, as did DO to a lesser extent. Therefore, USEPA's Environmental Fluid Dynamics Code (EFDC), which is a full 3-D hydrodynamic and water quality model, was selected to model the complex estuarine environment.

EFDC is capable of predicting hydrodynamics, nutrient cycles, DO, temperature, and other parameters and processes pertinent to the TMDL development effort for the estuarine section. It is capable of representing the highly variable flow and water quality conditions within years and between years for the estuary. As with RMA-2, RMA-11, and CE-QUAL-W2, EFDC has a proven record in the environmental arena and model results can be directly compared to ODEQ, Regional Water Board and Tribal water quality criteria. A major advantage of EFDC is that it is USEPA-endorsed and supported and available freely in the public domain.

The combination of the *PacifiCorp Model* (RMA and CE-QUAL-W2), with enhancements, and the EFDC model for the estuary resulted in the Klamath River model used for TMDL development. Table x-x identifies the modeling elements applied to each river segment. These segments are depicted graphically in Figures 4 and 5. Linkages between the different modeling segments were made by transferring time-variable flow and water quality from one model to the next (e.g., output from the Link River model became input for the Lake Ewauna-Keno Dam model).

Figure 4: Model segments in Oregon and Northern California

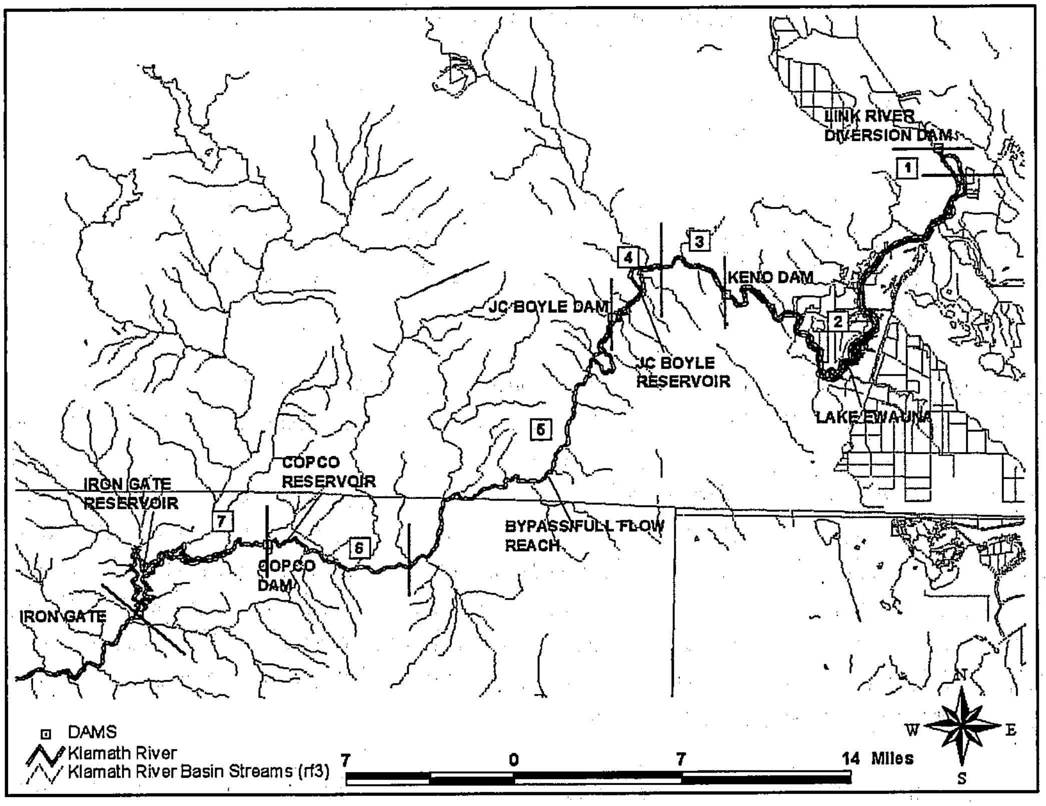


Figure 5: Model segments in California

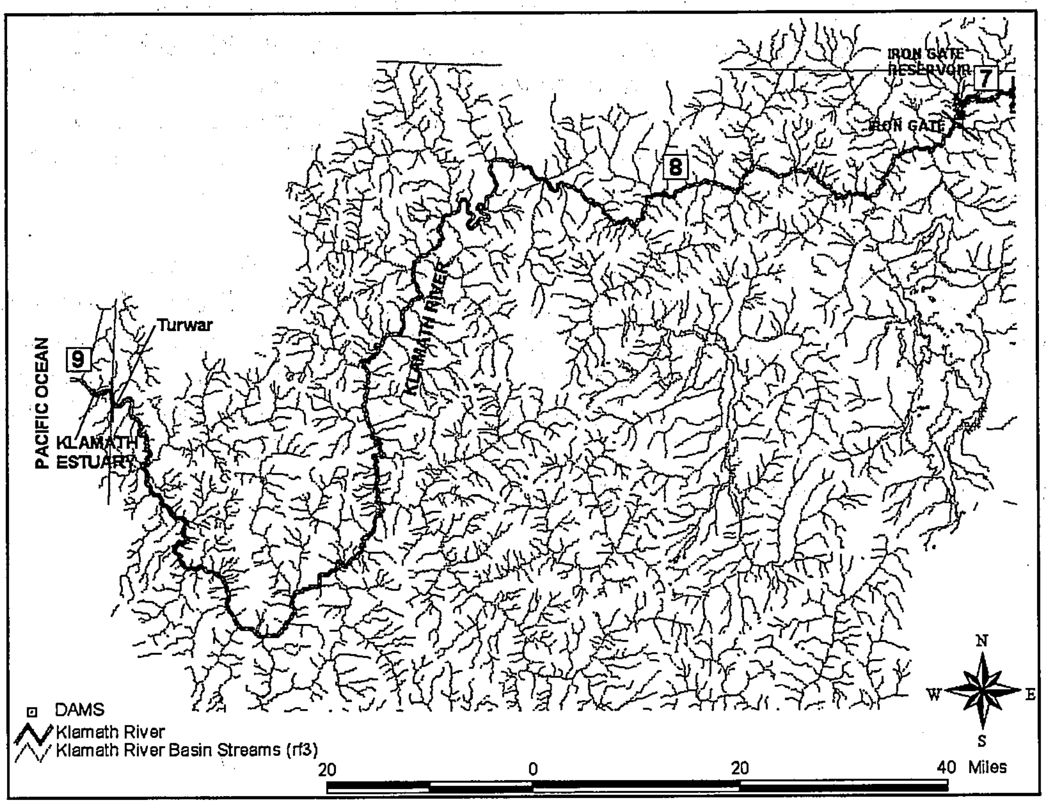


Table 3. Models applied to each Klamath River and estuary segment

Modeling Segment #	Modeling Segment	Segment Type	Model(s)	Dimensions
1	Link River	River	RMA-2/RMA-11	1-D
2	Lake Ewauna-Keno Dam	Reservoir	CE-QUAL-W2	2-D
3	Keno Dam to J.C. Boyle Reservoir	River	RMA-2/RMA-11	1-D
4	J.C. Boyle Reservoir	Reservoir	CE-QUAL-W2	2-D
5	Bypass/Full Flow Reach	River	RMA-2/RMA-11	1-D
6	Copco Reservoir	Reservoir	CE-QUAL-W2	2-D
7	Iron Gate Reservoir	Reservoir	CE-QUAL-W2	2-D
8	Iron Gate Dam to Turwar	River	RMA-2/RMA-11	1-D
9	Turwar to Pacific Ocean	Estuary	EFDC	3-D

Following model calibration and verification exercises, the model was run to simulate DO concentrations under estimated natural baseline conditions (i.e., T1BSR). Variables were adjusted and natural boundary conditions estimated for this simulation. Most importantly, the T1BSR model run simulates a free-flowing river without any dams. The Klamath River TMDL Staff Report, including extensive documentation of the water quality models, was peer reviewed in February 2009.

V.2.5.3 Natural Conditions Baseline - Background Loads

The Klamath River TMDL models were applied to characterize natural baseline water quality conditions of the Klamath River. In estimating the natural baseline water quality conditions of the Klamath River the following characteristics about the Klamath River watershed were incorporated.

The underlying geology in much of the Upper Klamath basin is of volcanic origin. Soils derived from this rock type are naturally high in phosphorus (Walker 2001). Through natural erosion and leaching processes these soils contribute a high background phosphorous load to Upper Klamath basin waters. In a nutrient loading study conducted by Rykbost and Charlton (2001), monitoring of several natural artesian springs in the upper Klamath basin were characterized by high levels of nitrogen and phosphorus, demonstrating the high natural background loading of nutrients. Upper Klamath Lake has long been noted for its eutrophic condition and demonstrated presence of high levels of organic matter (algae), including nitrogen fixing blue-green algae (Kann and Walker 2001). This nutrient and organic-matter rich Upper Klamath Lake water is the headwaters source of the Klamath River.

Within the Klamath Mountains Province of the mid- and lower-Klamath River, the underlying geology is not volcanic, and therefore does not tend to have the high levels of nitrogen and phosphorus characteristic of the Upper Klamath basin. Consequently, the tributaries that drain to the Klamath River within this province have considerably lower nutrient concentrations. As a result, the quality of the Klamath River generally improves as it flows from the Upper Klamath basin to the Pacific Ocean.

Alkalinity is a measure of the ability of water to neutralize acids. In the natural environment, alkalinity comes primarily from the dissolution of carbonate rocks. Carbonate rock sources are rare in much of the Klamath basin due to its volcanic origin. As a result, the Klamath River has a relatively low alkalinity (<100 mg/L). The low alkalinity provides for a weak buffering capacity of Klamath River water. Photosynthetic activity removes carbon dioxide in the water (in the form of carbonic acid) which increases the water pH. Natural alkalinity serves as a buffer to minimize the photosynthetically induced increase in pH. In low alkalinity waters such as the Klamath River, this buffering capacity is frequently exceeded and high pH values are observed during daytime hours when photosynthesis is occurring. The large daily variation of pH observed in the Klamath River is caused by photosynthetic activity in the low alkalinity water.

Further exacerbating the effect of the naturally productive and weakly buffered system is the presence of regionally high ambient summer air temperatures, and the resulting high heat load to the shallow and predominantly un-shaded Upper Klamath Lake. These naturally warm waters are the source of the Klamath River. In addition, the east-west aspect of much of the Klamath River also makes it prone to heating, even within the steep gorges of some reaches of the river.

In summary, the high ambient air temperatures, coupled with the high levels of biological productivity and respiration that is enhanced by the high levels of biostimulatory nutrients, yield large volumes of organic matter, seasonally high water temperatures, daily low dissolved oxygen, and high pH levels. All of these water quality conditions can be extremely stressful to many forms of aquatic life. These natural background heat, nutrient, and organic matter loads to the Klamath River underscore the very limited capacity of the river to assimilate anthropogenic pollutant sources.

V.2.5.2 Natural Baseline Conditions (T1BSR)

In order to fully evaluate applicable water quality standards, it was necessary to simulate natural baseline conditions throughout the Klamath River. The natural baseline conditions scenario (T1BSR) simulated the Klamath River from Upper Klamath Lake to the Pacific Ocean in the absence of all dams. The Klamath River model for this scenario used a different configuration than that for the current conditions. The entire length of the river from Upper Klamath Lake to just upstream of the estuary was simulated using the riverine RMA model. No CE-QUAL-W2 modeling segments were included since the natural configuration includes no impoundments.

The Upper Klamath Lake boundary condition for the model was based on the existing Upper Klamath Lake TMDL (ODEQ 2002). Specifically, median concentrations for water quality constituents and existing temperature were applied at the outlet and based on 1995 Upper Klamath Lake model output. Flow from Upper Klamath Lake was set at existing conditions, in order to maintain consistency with the existing conditions scenario. The flow balance for the current conditions model (when dams are present) and the reservoir operations limit the ability to represent natural flows. It should be noted that results for two model runs: one that used current conditions flows from Upper Klamath

Lake and one that used estimated flows from a natural regime (USBR 2005), were compared and not found to be substantially different.

Permitted point sources were removed from the model (i.e., both flow and water quality contributions were removed). The Lost River Diversion Channel (LRDC) and Klamath Straits Drain (KSD) were represented using current conditions flow, however, their water quality and temperature were set to be the same as Upper Klamath Lake. Current flow was again used to maintain consistency with the current conditions scenario in order to calculate pollutant load reductions, and associated TMDL load allocations, necessary to meet water quality standards. For tributaries to the Klamath River in California, natural and TMDL conditions were represented, depending on the tributary.

In summary, the key components of the natural conditions baseline scenario are:

- Representation of the river with no dams;
- The Upper Klamath Lake (UKL) boundary condition based on existing UKL TMDL compliant conditions;
- Absence of all point sources;
- LRDC and KSD represented using current conditions flow, but water quality set equal to UKL TMDL compliant conditions; and
- California tributaries flow and water quality conditions set at estimated natural and existing TMDL compliant conditions.

The model simulation was run for the year 2000.

<u>V.2.5.3 Discussion of Results</u>

The results of the model simulation of natural background DO conditions are expressed as hourly measures of DO at key locations throughout the watershed beginning at the Oregon-California state line and continuing down through the estuary. Upon plotting the simulated data for individual sites, TMDL staff determined that the natural background simulation indicated periods of noncompliance with the existing Table 3-1 background DO objectives. Figures 6 illustrates the hourly fluctuations of simulated DO throughout the year downstream of Iron Gate Dam as compared to the 8.0 mg/L DO currently applicable at that site. Graphic representations of data fro other sites are included in Appendix G. These figures show that in the absence of anthropogenic influences (e.g., dams, point source discharges, and non-point source discharges) DO is regularly less than 8.0 mg/L for some portion of the time between the months of June and September.

Staff conducted another assessment to compare simulated natural DO to proposed life cycle DO requirements to determine whether or not these objectives could be met under natural conditions. Figure 7 illustrates the hourly fluctuations in simulated DO throughout the year downstream of Iron Gate Dam on the Klamath River as compared to the updated life cycle DO requirements. Graphic representations of data for other sites on the Klamath River are included in Appendix H.

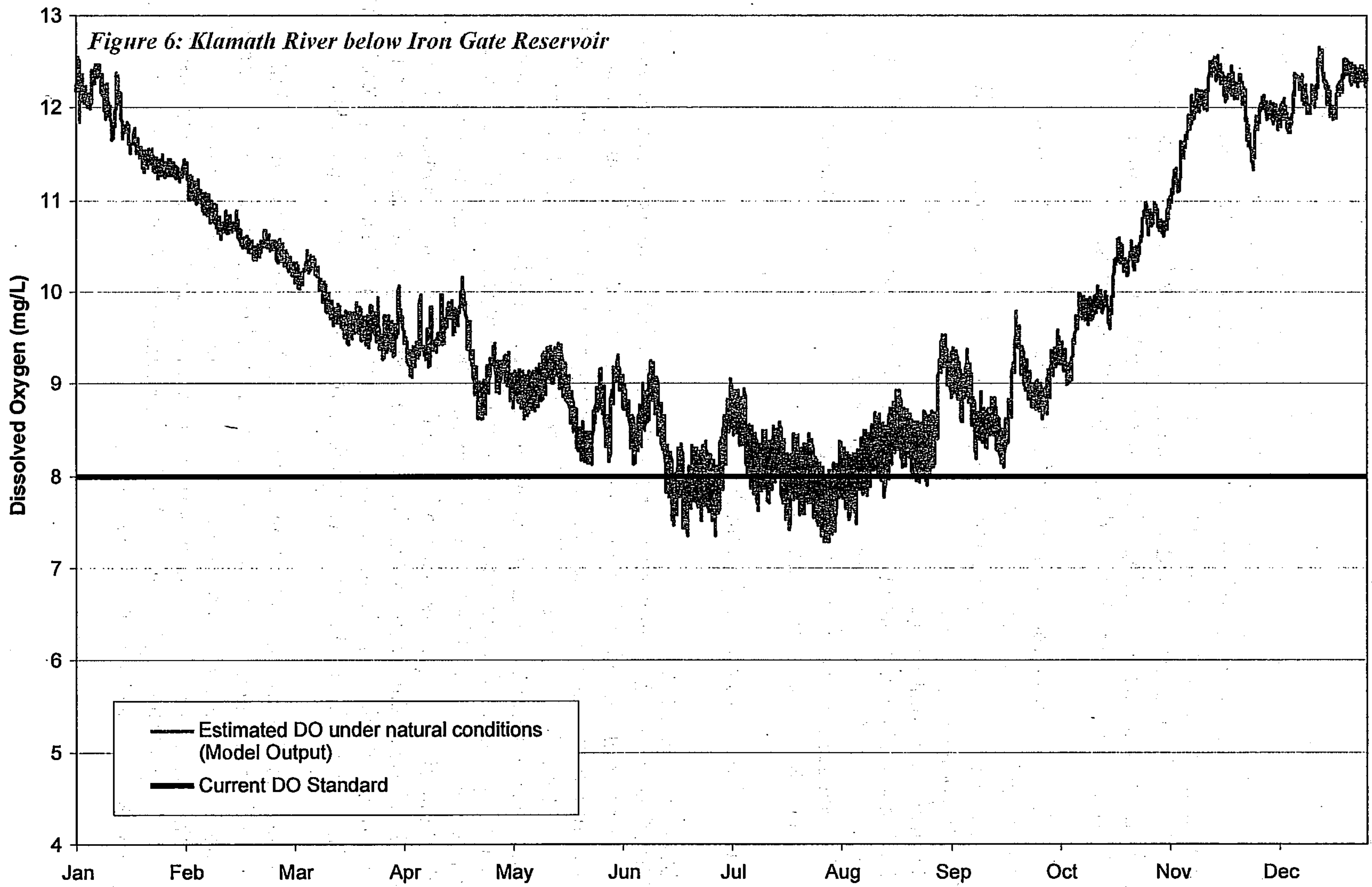


Figure 6: Klamath River below Iron Gate Reservoir
Dissolved Oxygen (mg/L)
13
12
11
10
9
8
7
6
5
4
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Estimated DO under natural conditions (Model Output)
Current DO Standard

Figures 7: Estimated daily minimum DO under natural conditions (TIBSR) as compared to proposed life cycle requirements: Downstream of Iron Gate Dam on the Klamath River.

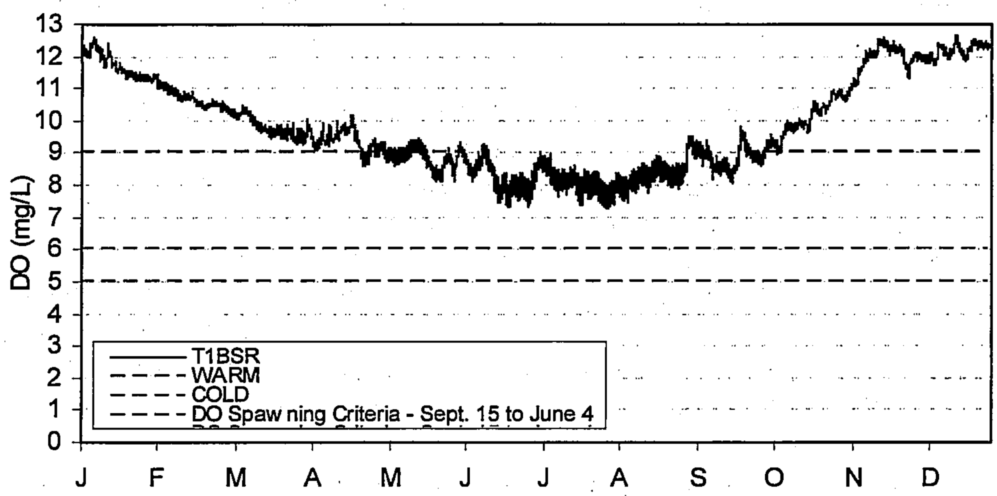
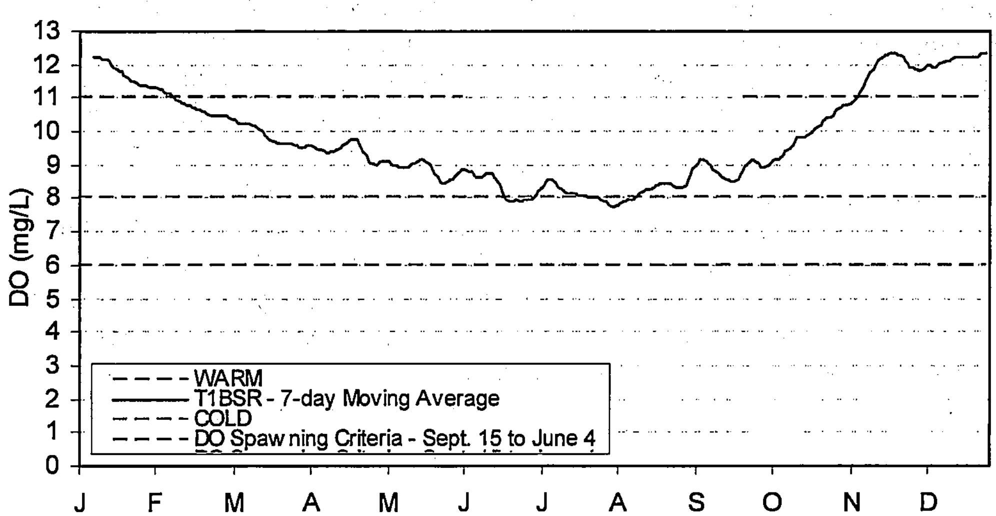


Figure 8: Estimated 7-day average DO under natural conditions (T1BSR) as compared to proposed life cycle requirements: Downstream of Iron Gate Dam on the Klamath River.



These figures show that in the absence of anthropogenic influences (e.g., dams, point source discharges, and non-point source discharges) simulated ambient water quality conditions achieve the daily minimum DO requirements for warm water fish (5.0 mg/L) and cold water fish (6.0 mg/L) throughout the year. It is during the spawning season (including early development), estimated to last from September 15 through June 4, that simulated water quality conditions do not appear to consistently meet updated life cycle requirements (9.0 mg/L during spawning, egg incubation, and early development).

During the first couple of weeks of the spawning season (e.g., estimated as September 15 through September 30), simulated DO at most of the stations is less than 9.0 mg/L. But, it varies from 9.0 mg/L by less than 1 mg/L (≥8.0 mg/L). Similarly, simulated DO at stations from the state line and to the confluence with the Scott River begins to decrease below 9.0 mg/L in April and downstream of the Scott River beginning in May. Again, the variance from 9.0 mg/L is generally no more than 1 mg/L (≥8.0 mg/L).

More dramatic, however, is the comparison of simulated natural background DO conditions to 7-day moving average life cycle requirements, specifically the spawning requirements. In this comparison, simulated ambient water quality does not meet the 11.0 mg/L 7-day average at individual stations for 3-6 months of the 7 ½ month period in which it is required, depending on the station. As a general matter, the weekly average DO appears to reach a peak in late October, plateau through early January and then begin to steadily decrease until reaching a low in late July/early August. Weekly average DO then begins to increase again until reaching a peak in late October. The increases and decreases in seasonal DO appear to be primarily a function of temperature.

Staff has developed two hypotheses to explain the high degree of dissimilarity between DO under natural conditions and 7-day average spawning requirements.

1. The Klamath River has historically had large runs of anadromous fishes with diverse life histories (NRC 2004). Coho salmon, spring-run Chinook salmon and summer steelhead in particular depended heavily on tributaries to complete their life cycles and sustain their populations (NRC 2004). The mainstem Klamath River water quality conditions may not ever have been optimal for these stream-type salmonids. But, their large dependence on higher quality tributary conditions may have ensured their success in the basin until the degradation of tributary conditions were well underway. If this is the case, then the protection of DO and temperature refugia is paramount to the protection of salmonids.
2. The 7-day average 11 mg/L DO water quality criteria is designed to ensure that there exists in the intragravel environment a 7-day average DO condition of 8 mg/L. USEPA (1986) recommends adding 3 mg/L to the intragravel requirement to calculate an appropriate water column requirement based on the findings of Koski (1965). But, the average intraredd DO concentration as measured by Koski (1965) was about 2 mg/L below that of the overlying water with intraredd variation of 5 or 6 mg/L (Koski 1965). In high gradient streams with little embeddedness or sediment oxygen demand, a lower correction factor may be appropriate. There is no information at present by which to alter the 3 mg/L correction factor.

V.2.6 Summary of Staff Observations regarding the Revision of Background DO Objectives

1. The data used to develop the background DO objectives contained in Table 3-1 of the Basin Plan were collected by grab sample during day light hours, frequently missing the true daily minimum DO conditions more often experienced during the night. Nonetheless, the Table 3-1 DO objectives are identified as daily minimum objectives.

2. DO monitoring is often done using a datasonde DO probe that is capable of recording DO concentrations over the course of 24 hours or longer. The daily minimum values obtained from a continuous DO dataset is not reasonably comparable to DO objectives based on day time data.
3. The background DO objectives contained in the Table 3-1 of the Basin Plan represent DO conditions as measured during the 1950s and 1960s when the landuse history of the North Coast Region had already resulted in water quality impacts, likely including impacts to DO.
4. Most of the waterbodies listed in Table 3-1 of the Basin Plan are required to meet a 7.0 mg/L DO objective. The capacity of water to hold DO at saturation is affected by temperature, atmospheric pressure, and salinity. At standard pressure in freshwater, water at high elevations and during high temperatures does not always have the capacity to hold 7.0 mg/L of DO, even at 1005 saturation.
5. Modeling conducted in support of the Klamath River TMDL for DO and other parameters demonstrates that in the absence of anthropogenic sources and activities (i.e., under natural conditions), various locations throughout the Klamath River are unable to consistently meet the background DO objectives as they are listed in Table 3-1 of the Basin Plan.
6. The protection of tributaries that provide cold water and DO refugia may be important, particularly in waterbodies unable to meet life cycle DO objectives due to natural conditions, such as the Klamath River.
7. There is some reason to believe that the 3 mg/L factor used to convert intragravel requirements to water column objectives may be over protective in some areas.

CHAPTER VI. ALTERNATIVES

Staff has evaluated the efficacy of several options, known as Alternatives, to determine the best means of addressing the issues raised in this staff report. In summary, the issues to be addressed are as follows:

1. Since the development of the DO objectives in 1975, several native fish species have become at risk of extinction.
2. The life cycle DO objectives do not adequately protect against the effects of multiple days or weeks of low DO conditions.
3. The SPWN DO objective is underprotective of pre-emergent fry.
4. The background DO objectives are outdated in light of new sampling capabilities that allow for continuous monitoring over a 24-hour period or longer.

The California Environmental Quality Act (CEQA) requires consideration of at least two alternatives, including a "no action" alternative. For the purpose of this analysis, staff has developed 3 alternatives. They are 1) No action; 2) Adoption of revised DO objectives specific to the Klamath River only; and, 3) Adoption of revised DO objectives for the whole region.

VI.1 No Action Alternative

With respect to DO, the "no action" alternative is to retain the DO objectives as written in the Basin Plan without update or revision. The No Action Alternative would leave Table 3-1 unchanged, including background DO objectives developed based on grab sample data from the 1950s and 1960s. As an example, the background DO objectives would be retained for the Klamath River, even given the results of the Klamath River TMDL for DO demonstrating that natural conditions (in the absence of anthropogenic effects) result in periodic DO concentrations less than the given objectives. The life cycle DO objectives would continue to protect against acute effects. But, they would provide no protection against the chronic effects of DO stress, including reduced reproductive success, reduced growth, and increased susceptibility to disease. The background DO objectives would continue to apply instead of life cycle DO objectives in those waterbodies listed in Table 3-1.

VI. 2 Klamath River Alternative

This alternative would retain the existing DO objectives for the whole Region *except* the Klamath River. In this alternative, the site-specific DO objectives included in Table 3-1 of the Basin Plan would be updated for the Middle Klamath River HA and the Lower Klamath River HA based on the results of modeling conducted in support of the TMDL for DO. Specifically, new minimum and 50% lower limits would be derived from the output of the model run that was designed to depict the Klamath River under natural conditions, including a natural stream channel configuration (e.g., without dams), natural concentrations of nutrients and organic matter, and natural temperatures.

In favor of this alternative is that DO objectives for the Klamath River would provide a more accurate representation of background conditions than the DO objectives currently contained in Table 3-1. In particular, the daily minimum DO objectives would represent true daily minimums such that continuous monitoring data over 24-hours or longer could reasonably be compared to the objectives for determining compliance and other purposes. Further, the Regional Water Board would be able to demonstrate to USEPA that the source reductions as calculated in the Klamath River TMDL would result in compliance with the DO objectives, a demonstration that could not be made in the absence of their revision.

This alternative, however, would leave threatened and endangered species under-protected during some times of the year and during some life cycle stages in some of the other waterbodies of the Region. This is because the life cycle DO objectives, not being updated, would continue to protect against the acute effects of DO depletion, only. For the other waterbodies included in Table 3-1 of the Basin Plan, except for the Klamath River, the DO objectives would continue to provide a poor representation of daily minimum background conditions, making assessment of compliance and/or impairment difficult.

VI.3 Region-wide Alternative

There are three main components of the existing DO objectives: the life cycle DO objectives, the background DO objectives, and the relationship between the two. The Region-wide Alternative includes several sub-alternatives related to the revision of each of these main components.

VI.3.1 Region-wide Alternative—Revision of the Life Cycle DO Objectives

If some revision is otherwise to be made to the DO objectives, then one of the most simple and straightforward elements of the revision is to update the life cycle DO objectives based on the recommendations in USEPA (1986). An update to the life cycle DO objectives would include:

- The addition of 7-day average limits for SPWN and COLD as described in Chapter V;
- The elimination of the 7.0 mg/L daily minimum SPWN objective as under-protective;
- The expansion of the period in which the 9.0 mg/L daily minimum SPWN objective applies to ensure protection of pre-emergent fry; and,
- The addition of a 7-day average limit for WARM.
- The addition of a narrative objective for EST.

In updating the life cycle DO objectives in this way, the Basin Plan would provide for the range of DO conditions required of aquatic species in the Region.

VI.3.2 Region-wide Alternative—Revision of the Background DO Objectives

The staff report clearly demonstrates the need to update the background DO objectives. To leave Table 3-1 without revision would jeopardize the integrity of the monitoring and compliance programs. The project of updating the background DO objectives, however, is a very difficult one.

VI.3.2.1 Modeling

One option is to model background DO conditions for each waterbody listed in Table 3-1. The experience gained from the Shasta River and Klamath River TMDLs for DO, as well as the Laguna TMDL for DO now underway, could help to streamline the data collection and modeling effort. Nonetheless, the time and expense in modeling DO conditions in each waterbody listed in Table 3-1 would be tremendous and require a significant redirection in staff priorities.

VI.3.2.2 Estimate Natural Background using Percent Saturation and Natural Temperatures

Another option is to rely on the observation that DO in healthy streams and rivers approaches saturation, fluctuating slightly due to the natural processes associated with photosynthesis and decomposition (Deas and Orlob 1999). The range of fluctuation in saturation in such a system is generally defined as 80-100% (Hauer and Hill 2007; SFBRWQCB 2007; Moyle 2008). With this information, it is possible to establish DO concentrations representative of background conditions based on what would be expected at a given percent saturation. To calculate background DO concentrations in this way, one would need to establish the appropriate percent saturation representative of background conditions, the natural receiving water temperatures at a given site, site salinity, and site barometric pressure.

Percent Saturation Representative of Background Conditions

There are numerous regions, states and countries that utilize percent saturation as a water quality criterion for DO. For example, Region 2 (San Francisco Bay) requires that the median DO concentration for any three consecutive months not be less than 80% of the DO content at saturation (SFBRWQCB 2007). It further states that in areas unaffected by waste discharges, a level of about 85% of oxygen saturation exists (SFBRWQCB 2007). Region 3 (Central Coast) requires that median values not fall below 85% saturation as a result of controllable water quality conditions (CCRWQCB 1994). Region 5 (Central Valley) requires that for those surface water bodies outside the legal boundaries of the Delta, the monthly median of the mean daily DO concentration shall not fall below 85% of saturation in the main water mass (CVRWQCB 2007). It further requires that for water bodies unable to meet concentration-based DO objectives due to natural conditions, DO must be maintained at or above 95% of saturation (CVWQCB 2007). Finally, Region 8 (Santa Ana) requires that waste discharges shall not cause the median DO concentration to fall below 85% of saturation (SARRWQCB 2008).

The State of Oregon applies a 90% saturation criterion in those COLD waterbodies unable to meet concentration-based limits due to conditions of barometric pressure, altitude and temperature, and 95% saturation in SPWN waterbodies under the same conditions. The Hoopa Valley Tribe applies a 90% saturation criterion under natural receiving water temperatures in those COLD and SPWN waterbodies unable to meet concentration-based limits due to natural conditions. The National Rivers Authority of England requires DO in their RE1 waterbodies (very high quality, suitable for all fisheries) to be at or above 80% of saturation (NRA 1994).

Staff propose that the DO concentration at or above 85% of saturation at natural receiving water temperatures reasonably represents the daily minimum DO expected under natural conditions. Staff bases this proposal on the following:

1. 85% of saturation falls within the range of saturation values (80-100%) expected to represent natural background.
2. ODEQ (1995) called a Technical Advisory Committee, chaired by Gary Chapman of USEPA, to review its water quality objectives for DO. The Technical Advisory Committee concluded that Oregon's former water quality criteria of 90% and 95% of saturation were too conservative because natural conditions in some streams will cause DO levels to fall below 90%.
3. Davis (1975) demonstrated that few members of a salmonid population will show the effects of oxygen stress if DO is at or above 85% saturation at temperatures up to 20°C and 93% of saturation at temperatures up to 25°C, suggesting that a percent saturation less than 85% may cause harm at higher temperatures. Because of the threatened and endangered status of some salmonid species in the North Coast Region, staff believes it necessary to provide at least the protection afforded by 85% of saturation, recognizing that natural systems do not provide "ideal" conditions at all times. See Chapter IV regarding the DO tolerances and adaptive behavior of salmonids and other fishes.
4. Many streams in the North Coast Region have been affected by elevated stream temperatures due to sedimentation, flow reductions, agricultural return flows, loss of riparian shade, and other factors. Because DO fluctuates as a result of variation in temperature, and some of the waterbodies in the North Coast Region are listed on the 303(d) list for temperature impairments, staff propose that background DO objectives be calculated not based on existing stream temperatures, but natural stream temperatures. This approach makes biological sense since an organism's metabolic rate increases with increased temperature thereby increasing its DO requirement at the same time that DO at saturation is falling. And, it provides a margin of safety to better ensure that a background DO objective calculated in this way is reasonably conservative and protective. A discussion of techniques for such an analysis is included below.

Natural Receiving Water Temperatures

A variety of common techniques are available for estimation of natural stream temperatures at a given site. Reasonable estimates of natural temperatures can be developed by comparison with reference streams, simple calculations, or use of computer models. Though a number of techniques may be applied, the most appropriate technique will depend on the site-specific conditions of the location of interest. Factors that may require a more in-depth analysis are:

- significant alteration of natural hydrologic conditions,
- unique hydrologic features such as springs or cold tributaries,
- estuarine environments, and
- thermal stratification.

<u>Defining the alteration of thermal influences</u>

The first step in estimating natural stream temperatures is to identify the drivers of stream temperature that have been altered from natural conditions. Stream temperature drivers include solar radiation, advection of cold water, bed conduction, convection, and evaporation. Once the altered stream temperature drivers have been identified, the effects of those alterations can be assessed using the tools described below.

Comparison with reference streams

Reference streams can be helpful for estimating natural temperatures if the reference stream closely resembles the location of interest in a natural state. Headwater stream reaches and mainstem trunk stream reaches are two types of stream environments that are particularly suited for this type of analysis, if shade and meteorological conditions are comparable.

Headwater streams are suited to these types of comparisons because they are close to the stream source, groundwater. Groundwater is typically constant year round, and generally defines the lower temperature limit for streams in the summer months. The lower reaches of mainstem trunk streams (e.g., the mainstem Eel River at Alderpoint) are also suited to these types of comparisons because they typically represent temperatures that are in equilibrium with heat sources and sinks. Maximum stream temperatures of the lower reaches of major rivers are typically very similar in the summer months. Stream reaches in between the headwaters and lower mainstem stream reaches are only suited for comparison with reference streams if the riparian, hydrologic, and meteorologic conditions are comparable from the headwaters to the location of interest, and there are no unique thermal or hydrologic conditions present.

Simple Calculations

The use of simple calculations can be useful in estimating natural steam temperatures. The mixing equation, $Q_{ds}*T_{ds} = Q_{us}*T_{us} + Q_{trib}*T_{trib}$ (where the Qs represent flows, Ts represent temperatures, ds denotes downstream, us denotes upstream, and trib denotes tributary temperatures and flows) is a helpful equation for calculating the change in temperature downstream of a confluence of two streams. Similarly, Cafferata (1990) demonstrated that a modified version of Brown's equation gives a reasonable estimate of temperature change due to alteration of solar exposure for short stream reaches, where the conditions in the reach are homogeneous.

Computer models

Many computer models have been developed with the ability to calculate stream temperatures. Some of these models were developed for other purposes and only calculate temperature in order to calculate other water quality related processes, while others were specifically developed with stream temperature applications in mind. Either type of model can be used to estimate stream temperatures if all the relevant processes and factors are accounted for in the model. For instance, some models do not take into account riparian shade, while others do.

One of the more commonly used simple stream temperature model is SSTEMP, maintained by the USGS. SSTEMP is considered a simple model because it requires no compiler or complicated input files. The calculation scheme is also simple, relying on daily average input data to estimate daily average stream temperatures for a single reach. Accordingly, SSTEMP is well-suited for simple thermal situations. It can be used to evaluate changes in channel geometry, vegetation, meteorologic conditions, and changes in flow. A limitation of the SSTEMP model is that because the input data are daily averages, the model does not perform well when the model is evaluating a reach that represents significantly more or less than one day's travel time. Also, the SSTEMP model does not perform well if the reach in question encompasses drastic differences of shade, flow, channel geometry, or meteorology within it.

Deterministic computer models are useful in situations where a reach of stream, or a stream network, requires a more sophisticated analysis. These models are designed to accommodate variable conditions in time and space, which requires that those variables be defined in time and space. The definition of those conditions requires large amounts of data. To use a deterministic model to estimate natural temperatures, the natural condition of each factor that influences stream temperatures must be estimated over the entire time and spatial extent of the analysis.

The Klamath TMDL temperature analysis is an example of the use of deterministic models to estimate natural temperatures. In that analysis, natural temperatures were estimated by defining the estimated natural conditions of the Klamath River and calculating the temperatures that would result from those conditions using the RMA-2 and RMA-11 models. Estimates of natural flows from Upper Klamath Lake and downstream tributaries were developed to define natural hydrologic conditions. Similarly, the natural, un-dammed geometry of the Klamath River was used to define the natural channel geometry. Finally, shade and meteorological conditions were assumed to be effectively natural.

Assessment of this Alternative—Percent Saturation

The benefit of calculating background DO objectives based on percent saturation and natural receiving water temperatures is that it does not require an abundance of DO data or extensive DO modeling. This is important because the DO dataset for the North Coast Region is very sparse and unevenly distributed. A very significant effort and prioritization of monitoring resources would be required to collect sufficient data to populate a DO water quality model and test its efficacy. This is hampered by the relatively few datasonde data loggers available for deployment at any given time. Further, the modeling exercise itself could require significant time and resources in its development, tuning, running, and testing. The Klamath River TMDL is an example of the effort that could be required.

The challenge of calculating background DO objectives using this technique is that it requires the estimate of natural receiving water temperatures. This exercise, like that of DO modeling, requires the availability of data; and, may require a significant amount of data if a more complex temperature model is required. However, temperature data is much more readily available throughout the North Coast Region then is DO data and much more readily obtained, if necessary. In addition, as described above, there are some simple ways in which such an estimate could be developed.

An additional challenge of calculating background DO objectives using this technique is that it might not reasonably apply to streams and rivers that have DO-related attributes that are uncharacteristic of most other North Coast streams. For example, 85% of saturation might not reasonably represent the natural diurnal fluctuation in DO in a low gradient, widely meandering, wetland complex with large solar exposure and high summer temperatures. In this example, a background DO objective might more reasonably be developed as a site specific objective based on the unique attributes of the system.

VI.3.3 Region-wide Alternative—Life Cycle or Background Precedence?
The Basin Plan currently only requires the application of life cycle DO objectives in those streams not otherwise listed in Table 3-1 of the Basin Plan. The result of this structure is that few of the Region's waterbodies are required to meet life cycle DO objectives. This is significant because the background DO objectives are given as a daily minimum and the annual average of monthly means. This allows for compliant conditions to include multiple days and weeks of significantly depressed DO, even during critical periods of spawning, egg incubation and early life stage development. Without a change to this relationship, the SPWN beneficial use will continue to be under-protected in most of the Region's waterbodies.

An alternative is to reverse the relationship between the life cycle DO objectives and background DO objectives. In this scenario, the life cycle DO objectives would take precedence and only for those waterbodies in which natural conditions prevent the attainment of the life cycle objectives would background DO objectives apply.

There are several benefits to this alternative. First, the life cycle DO objectives—as long as they are updated—would provide adequate protection to all the beneficial uses, including protection of threatened and endangered species, sensitive species, and sensitive life stages. Second, the life cycle DO objectives are based on decades of robust science, voluminous data, and peer review. The background DO objectives, on the other hand, will necessarily be based on limited data and provide only an estimate of background conditions.

The challenge of implementing this alternative is in determining whether or not natural conditions are preventing the attainment of life cycle DO objectives in a given waterbody. In a memorandum dated November 5, 1997, the Director of the EPA Office of Science and Technology (Davies 1997) specified a policy for "establishing site specific aquatic life criteria equal to natural background:"

> "States and Tribes may establish site specific numeric aquatic life water quality criteria by setting the criteria value equal to *natural* background. Natural background is defined as background concentration due *only* to non-anthropogenic sources, i.e., non-man-made sources. In setting criteria equal to

natural background the state or tribe should, at a minimum, include in their water quality standards:

1. a definition of natural background consistent with the above;
2. a provision that site specific criteria can be set equal to natural background; and
3. a procedure for determining natural background, or alternatively, a reference in their water quality standards to another document describing the binding procedure that will be used."

USEPA Region 9, in its review and approval of the Hoopa Valley Tribe's water quality standards, required that the "natural conditions" clause included in its standards not be implemented until an approvable procedure for determining "natural conditions" was identified. As such, staff believes it necessary to establish a procedure here.

VI.3.3.1 Procedure for determining if natural conditions prevent attainment of objectives

There are essentially three steps to determining if natural conditions prevent the attainment of life cycle DO objectives.

The first step is to confirm that water quality conditions in a waterbody do not meet the life cycle DO objectives. This is accomplished by conducting continuous monitoring during the weeks or months in which noncompliance is expected, establishing a quantitative record of noncompliance. It is understood that periodic noncompliance with life cycle DO objectives might occur even in waterbodies in which life cycle DO objectives are typically met. For example, prolonged drought, extreme flooding and sedimentation, or excessive organic loading after a fire could result in extraordinary or unusual conditions that depress DO temporarily. Periodic noncompliance such as this, a temporary and unusual circumstance, do not constitute reason to calculate a new DO objective based on percent saturation. It is the intention of this alternative that only long-lived noncompliance resulting from permanent natural conditions characteristic of the basin constitute a reason for recalculation (e.g., phosphorus-rich geology, extensive wetland complexes, or ephemeral stream flow). As such, the DO data collected with the intention of proving noncompliance with life cycle DO objectives must be assessed within the context of recent climatic and other events temporarily affecting DO.

The second step is to develop a conceptual model of the elements affecting DO in the aquatic system of concern, both anthropogenic and natural. This is accomplished through a combination of both qualitative and quantitative information, as appropriate, including: a general understanding of DO relationships, historical water quality and land use records, and existing data. The result should be a conceptual model similar to that presented in Chapter III in which the site specific characteristics of the waterbody in question are presented and their relationships among each other identified. The intention of this step is to identify all the factors contributing to the pattern and range of DO observed in the basin. At this stage, an estimate of the importance of individual elements with respect to their overall affect on DO is helpful. If existing data and information are available, these estimates could be given as quantities or ranges of quantities. Or, they might be expressed as percentages based on the importance of their influence on DO concentrations.

The third step is to estimate DO concentrations in the waterbody in question under natural conditions. The method used to develop these estimates will depend in large part on the characteristics of the basin. As such, staff can not prescribe a specific method that can with assurance apply in all basins of the Region. Instead, staff can describe the goals of this step and refer the reader to the discussion of the Klamath River TMDL in Chapter V as an example of how this question has been answered for that basin.

The goal of this step is to produce a reasonable estimate of DO resulting only from the influences of natural conditions so as to compare them to the life cycle DO objectives. This is accomplished by choosing a method that produces an equation in which the addition of all anthropogenic and natural sources/conditions influencing DO results in DO concentrations equivalent to those actually measured. The equation produced must be internally logical and consistent with the conceptual model produced in step two. Once anthropogenic sources/conditions are subtracted from the equation, the result should be an estimate of DO concentrations under natural conditions, only. These are then compared to the life cycle DO objectives to determine if life cycle DO objectives can be met.

It is important to keep in mind that the goal of this step is *not* to produce a site-specific objective of unequivocal accuracy. The development of site-specific objectives may be required in some basins where the application of 85% saturation under natural temperature conditions can not reasonably be expected to result in DO concentrations that represent true natural background conditions: estuarine systems, or systems experiencing periodic turnover, for example. Further, there may be basins or locations in the Region where neither life cycle DO objectives nor background DO objectives reasonably apply. For these situations, USEPA has produced guidance on the development of site-specific objectives.

VI.4 Proposed Alternative

Staff propose as the most efficacious alternative the Region-wide revision of the DO objectives, including:

- Revision of the life cycle DO objectives based on USEPA (1986) and other scientific literature as described in Section V.1.3;
- Elimination of the background DO objectives from Table 3-1 except for Humboldt Bay, Bodega Bay, and ocean waters.
- Inclusion of a "natural conditions" clause that allows for the calculation of background DO objectives based on 85% saturation under natural stream temperatures in those waterbodies or reaches of waterbodies where natural conditions prevent the attainment of life cycle DO objectives.

Proposed Basin Plan language is as follows:

"Dissolved oxygen concentrations shall conform to the following life cycle dissolved oxygen requirements.

Beneficial Use	Daily minimum objective (mg/L)	7-day average objective (mg/L)[7]
MAR, SAL	5.0	NA
WARM	5.0	6.0
COLD[8]	6.0	8.0
SPWN[9]	9.0	11.0

Dissolved oxygen concentrations in Humboldt Bay and Bodega Bay shall conform to a daily minimum objective of 6.0 mg/L. As required of the Ocean Plan, dissolved oxygen concentrations shall not at any time be depressed more than 10 percent from that which occurs naturally in ocean waters.

Upon approval from the Executive Officer, in those waterbodies for which the life cycle DO requirements are unachievable due to natural conditions[10], site specific background DO requirements can be applied as water quality objectives by calculating the daily minimum DO necessary to maintain 85% saturation under site salinity, site atmospheric pressure, and natural receiving water temperatures.[11] In no event may controllable factors reduce the daily minimum DO below 6.0 mg/L.

For the protection of estuarine habitat (EST), the dissolved oxygen content of enclosed bays and estuaries shall not be depressed to levels adversely affecting beneficial uses as a result of controllable water quality factors."

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[7] A 7-day moving average is calculated by taking the average of each set of seven consecutive daily averages.

[8] Water quality objectives designed to protect COLD-designated waters are based on the life cycle requirements of salmonids but apply to all waters designated in Table 2-1 of the Basin Plan as COLD regardless of the presence or absence of salmonids.

[9] Water quality objectives designed to protect SPWN-designated waters apply to all fresh waters designated in Table 2-1 of the Basin Plan as SPWN in those reaches and during those periods of time when spawning, egg incubation, and larval development are occurring or have historically occurred. The period of spawning, egg incubation, and emergence generally occur in the North Coast Region between the dates of September 15 and June 4.

[10] Natural conditions are conditions or circumstances affecting the physical, chemical, or biological integrity of water that are not influenced by past or present anthropogenic activities.

[11] The method(s) used to estimate natural temperatures for a given waterbody or stream length must be approved by the Executive Officer and may include, as appropriate, comparison with reference streams, simple calculation, or computer models.

CHAPTER VII. MONITORING PLAN

Monitoring is required to determine the environmental condition of a waterbody, its ability to support beneficial uses, and the degree of compliance with the Basin Plan, including water quality objectives. With respect to the proposed revisions to the Basin Plan for DO, monitoring should include measurements for:

1. DO, temperature, and salinity in the water column and
2. Atmospheric pressure at water column measuring stations.

Water quality data generally are collected in the region for one of three purposes: 1) to measure compliance with a discharge permit, 2) to identify water quality impairments requiring 303(d) listing, or 3) as a part of a specific study.

Regional Water Board staff issue National Pollutant Discharge Elimination System (NPDES) permits as well as Waste Discharge Requirements (WDR) for the control of both point source and stormwater discharges. Instream DO measurements are required upstream and downstream of a discharge. The upstream measurement is intended to represent ambient conditions while the downstream measurement is intended to reflect the impact of the discharge on the ambient condition. A violation of the water quality objectives results if the upstream measurement meets the water quality objective and the downstream measurement does not; or, if the upstream measurement does not meet the water quality objective and the downstream measurement is less than the upstream measurement. Staff recommends that:

1. DO measurements be continuous measurements collected less than or equal to once every hour within a 24-hour day. A reasonable break in the monitoring schedule should be allowed for the purpose of maintaining or replacing monitoring equipment.
2. DO weekly averages be calculated from the daily means of a moving 7-day period. Fewer than 7 daily means may be allowable in any 7-day period for the calculation of a weekly average to be acceptable.
3. The period of monitoring be adjusted based on site specific information indicating that less frequent monitoring will provide equivalent results.
4. Upstream monitoring be outside the sphere of influence of the discharge in question. It should also be outside the influence of any other known upstream point source discharges, if possible.
5. Downstream monitoring be established downstream of the discharge outfall a sufficient distance to ensure that the effects on DO of the discharge (e.g., conversion of organic matter, uptake of nutrients) are adequately captured. This determination may require a short field trial or simple modeling exercise.

Regional Water Board staff also implements the Surface Water Ambient Monitoring Program (SWAMP) in the North Coast Region. Annual data, including DO data, is collected from individual watersheds on a rotation. The SWAMP program maintains several datasondes and is capable of collecting continuous measurements over multiple days.

The data collected through SWAMP are used, in conjunction with data from other sources, to assess the condition of the Region's waterbodies, including the identification of waterbodies that are impaired and require listing on the Clean Water Act (CWA) 303(d) list. There are three waterbodies in the North Coast Region currently listed on the 303(d) list for impairments due to reduced DO: the Klamath River mainstem from the Oregon border to the estuary, the Shasta River Hydrological Area, and Laguna de Santa Rosa in the Russian River watershed. A Total Maximum Daily Load (TMDL) to correct the problem has been developed and adopted for the Shasta River. TMDLs for the Klamath River and Laguna de Santa Rosa are currently under development.

There are numerous other waterbodies in the Region, however, that are listed as impaired due to excess nutrients, elevated stream temperatures, and/or pH. These are indicators that often result in or are suggestive of excessive primary production and may impact DO concentration and saturation. These require further monitoring. Staff recommends that:

1. Waterbodies with impairments due to pH, ammonia, temperature, or nutrients should also be monitored for DO.
2. DO monitoring should be conducted on a continuous basis with measurements recorded less than or equal to once every hour within a 24-hour day and for at least a 7-day period. Simultaneously, temperature, salinity, and atmospheric pressure should also be collected to allow for the calculation of percent DO saturation.
3. The Regional Water Board should develop and distribute guidelines for the appropriate placement, maintenance, and reading of monitoring devices for the purpose of ensuring the collection of representative samples.

Finally, Regional Water Board staff and/or its cooperators occasionally conduct special water quality studies, which result in the collection of DO data or modeling. Such special studies might include investigations and analyses to: respond to complaint; support an enforcement action; support the 303(d) listing process; support the development of a TMDL; or otherwise determine compliance with the Basin Plan, permit, or TMDL. Occasionally, Regional Water Board staff participates in area-wide monitoring projects led by another agency, but including a water quality goal, which we serve. Staff recommend that:

1. Data collected under these auspices be included in a Region-wide ambient water quality database for future reference and analysis.
2. DO data be collected in a manner consistent with the proposed DO objective, including the percent DO saturation criteria, if adopted.

CHAPTER VIII.
IMPLEMENTATION PLAN

The Regional Water Boards adopt and implement water quality control plans for the protection and enhancement of water quality in the region, as required by the Porter-Cologne Water Quality Control Act (Porter-Cologne Act). In 1971 the North Coast Regional Water Quality Control Board first adopted two Interim Basin Plans, one for the Klamath Basin (1a) and the second for the North Coast Basin (1b). In 1975, the two plans were revised and went through another adoption process. In 1988 the two individual Basin Plans were combined into one plan, referred to since as the Water Quality Control Plan for the North Coast Region (Basin Plan). The Basin Plan has been amended numerous times since then most recently in 2007. The existing DO objectives have been in place since the Basin Plan was approved in 1975.

SWRCB (2004) describes the planning authority under Porter-Cologne to extend to any activity or factor that may affect water quality, including waste discharges, saline intrusion, reduction of waste assimilative capacity caused by reduction in water quantity, hydrogeologic modifications, watershed management projects, and land use. It further makes clear that all dischargers are subject to regulation under the Porter-Cologne Act including both point and nonpoint source dischargers (SWRCB 2004).

VIII. 1 Activities of Concern with respect to DO

The conceptual model for DO (Figure 1 and Appendix D) specifically identifies the following activities as influencing the presence of DO in an aquatic system: agricultural practices, forestry practices, fossil fuel extraction and refinement practices, other mining practices, construction practices, residential and commercial practices, recreational practices, and industrial practices. These activities have the potential to act as sources of: fire ash and smoke, animal wastes, mining wastes, septic system leachate, landfill leachate, fertilizers, vehicle emissions, industrial emissions, sewage treatment plant effluent, industrial effluent, stormwater discharge, and other historic or existing sources. In addition, these activities have the potential to alter environmental conditions in such as way as to alter the natural cycle of DO availability. For example, the installation of impoundments, alteration of land cover, alteration of the stream channel, increase in temperature, or increase in sediment delivery can impact the functioning of DO in an aquatic system.

As such, the conceptual model illustrates the importance of developing management measures designed to:

- Reduce the threat of the discharge of anthropogenic sources of nutrients, and organic matter including the discharge of agricultural return flows,
- Reduce the threat of discharge of warm water to a waterbody, including the discharge of agricultural return flows;
- Reduce the threat of anthropogenic sources of erosion and sediment delivery;
- Reduce the threat of direct alteration of the stream channel, such as through gravel mining;

- Reduce the threat of disturbance to wetlands, the flood plain and riparian zone;
- Reduce the threat of anthropogenic alteration to the natural pattern and range of flows, including stormwater management, groundwater protection, and control of water impoundment and withdrawal;
- Reduce the threat of loss or alteration (e.g., reduction in flow or increase in temperature) of cold water springs; and,
- Increase the availability of channel forming material (e.g., large woody debris) in the stream channel, riparian zone, and floodplain.

It further illustrates the importance of developing management measures designed to control vehicle and industrial emissions. This task, however, is out of the range of the Regional Water Board's authority.

VIII.2 Regulatory Program

The cornerstones of the Regional Water Board's regulatory program are the 1) waste discharge prohibition,2) the Waste Discharge Requirement (WDR), and 3) waivers of WDRs. As an example of the waste discharge prohibition, the Regional Water Board prohibits the discharge of wastes to all the waters of the Region except the Lost River and it further prohibits waste discharge to the Mad, Eel, and Russian Rivers during the period of May 15 through September 30 and under specific flow regimes. The Regional Water Board can issue exceptions to this prohibition, if necessary. The Regional Water Board can also issue new prohibitions to address specific water quality issues, as needed.

WDRs allow the discharge of waste to a water of the North Coast Region; but, they identify the pollutants of concern and the discharge limits necessary to ensure the protection of water quality, including compliance with the ambient water quality objectives and antidegradation policies of the Basin Plan. WDRs can be issued as individual permits (e.g., for a particular facility), group permits (e.g., for facilities within a particular watershed), or general permits (e.g., for facilities conducting a particular activity). The Regional Water Board also has the option to issue a waiver of requirements for facilities whose operations meet certain conditions if it is in the public interest.

VIII.2.1 Nonpoint Source Program

In 1988, the SWRCB issued a Nonpoint Source Policy outlining a three-tiered program by which nonpoint source pollution was to be controlled in the State. The first tier of the program called upon landowners to voluntarily comply with the Basin Plan, including compliance with water quality objectives. The Nonpoint Source Policy was updated in 2004 and more plainly made clear the obligation of the Regional Water Board to ensure compliance with the Basin Plan, even from nonpoint sources of pollution.

In 2000, the SWRCB developed a strategy for prioritizing those sources of nonpoint source pollution requiring immediate state attention. The "Plan for California's Nonpoint Source Pollution Control Program" (SWRCB 2000) identifies 6 categories of activities requiring priority management for the control of nonpoint source pollution in the state, including:

1. Agriculture;
2. Forestry;
3. Urban areas;
4. Marinas and recreational boating;
5. Hydromodification; and
6. Wetlands, riparian areas and vegetated treatment systems.

For these 6 categories of activities, the SWRCB (2000) further identifies 61 management measures to be implemented over a 15 year schedule, beginning in the 1998.

VIII.2.2 Existing Programs

The Regional Water Board currently implements a number of programs that reasonably and adequately address water quality issues such as DO. These include programs designed to control:

- Discharge of waste to waters of the State either directly or via stormwater discharges. These discharges are regulated under the National Pollutant Discharge Elimination System (NPDES) program.
- Discharge of waste as a result of timber operations.
- Discharge of waste as a result of dredging, filling, or other activities in wetlands that meet the federal definition of wetlands (410 certification program)
- Discharges of waste to land (Chapter 15 Program and Non-Chapter 15 Permitting, Surveillance, and Enforcement Program)

VIII.2.2.1 NPDES Permitting, Surveillance, and Enforcement

The National Pollutant Discharge Elimination System (NPDES) program is a federal program which has been delegated to the State of California for implementation. NPDES permits, sometimes also referred to as Waste Discharge Requirements (WDRs), are issued to regulate the discharge of municipal wastewater or industrial process, cleaning, or cooling wastewaters, commercial wastewater, treated groundwater from cleanup projects, or other wastes to surface waters only. All municipalities within the North Coast Region which discharge wastewater to surface waters are currently regulated by NPDES permits issued by the Regional Water Board. Non-municipal waste discharges typically regulated by NPDES permits in the North Coast Region include: canneries, fish hatcheries, wineries and other food processing plants, groundwater cleanup projects, hardboard manufacturing plants, pulp mills, sawmills, and gravel operations.

VIII.2.2.2 NPDES Stormwater

The goal of the Storm Water Program is to prevent or minimize the discharge of pollutants contained in storm water runoff to waters of the state. Common pollutants contained in storm water runoff include:

- Sediment: construction or other activities expose and loosen soils, while vehicles break-up pavement. Excessive sediment in water can effect the respiration, growth and reproduction of aquatic organisms, cause aesthetic impacts to receiving streams and affect spawning habitat of salmonids.

- Nutrients: Sources include fertilizer, lawn clippings, and car exhaust which contain nutrients like phosphorous and nitrogen. An overabundance of nutrients can accelerate the growth of algae and affect the availability of DO.
- Heavy metals and toxic chemicals: Sources of cars (brake pads, engine wear, etc) pesticides and herbicides. Maintaining and cleaning transportation vehicles can release solvents, paint, rust, and lead.. These chemicals may poison organisms or cause serious birth defects.
- Bacteria: Sources include failing septic tanks, sewer overflows, decaying organic material and the improper disposal of household pet fecal material. Some bacteria found in stormwater runoff can result in disease. Beach closures result from high bacteria levels.

There are three statewide NPDES stormwater permits issued by the SWRCB and implemented by individual Regional Water Boards. These permits are for the control of stormwater runoff from 1) industrial facilities, 2) construction sites, and 3) municipalities. The NPDES Stormwater permit program is implemented as a phased program in which facilities implement best management practices and monitor and improve management practices, as monitoring data indicates the need.

VIII.2.2.3 Land Disposal Program

The California Code of Regulations (CCR) Title 23 (Chapter 15) contains the regulatory requirements for hazardous waste. The Chapter 15 Program regulates the discharge to land of certain sold and liquid wastes. These wastes include municipal solid waste, hazardous wastes, designated wastes, and nonhazardous and inert sold wastes. In general, these wastes cannot be discharged directly to the ground surface without impacting groundwater or surface water, and therefore must be contained in waste management units (e.g., landfills) to isolate them from the environment.

The Non-Chapter 15 Permitting, Surveillance and Enforcement Program is a State mandated program under which Waste Discharge Requirements are issued to regulate the discharge of municipal, industrial, commercial and other wastes to land only. If the waste discharge consists only of non-process storm water, it may be regulated under the NPDES Stormwater program. The discharge of waste to surface water (rivers, streams, lakes, wetlands, drains, and the Pacific Ocean) is regulated under the NPDES Permitting, Surveillance, and Enforcement program.

All municipalities within the North Coast Region which discharge wastewaters to land are currently regulated by Waste Discharge Requirements issued by the Regional Water Board. Industrial, commercial, or other operations which discharge to municipal or other publicly owned wastewater collection systems are not required to obtain Waste Discharge Requirements under this program, but must comply with waste discharge requirements issued by the appropriate public entity.

Non-municipal waste discharges typically regulated by Waste Discharge Requirements under the Non-Chapter 15 Permitting, Surveillance and Enforcement program within the North Coast Region include: dairies, mines, mobile home parks, sawmills, and wineries.

VIII.2.2.4 Timber Operations

The Regional Water Board has been regulating discharges from logging and associated activities since 1972 which is consistent with the abundance of timber and water resources in the North Coast Region. The North Coast Region includes 12 % of the State's land area yet produces 48% of the private timber harvested within the State and 40% of the State's total runoff.

Timber harvesting activities with the greatest potential to impact waters of the State include: felling, yarding, and hauling of trees; road construction and reconstruction; watercourse crossing construction, reconstruction, or removal, herbicide applications, broadcast burning and other site preparation activities. Excessive soil erosion and sediment delivery associated with these activities can impact the beneficial uses of water by: 1) silting over fish spawning habitat; 2) clogging drinking water intakes; 3) filling pools creating shallower, wider, and warmer stream, and increasing downstream flooding; 4) creating unstable stream channels; and 5) losing riparian habitat. Timber harvesting in the riparian zone can adversely affect stream temperatures by removing stream shading which is especially a concern for temperature impaired waterbodies. Removal of large diameter trees in the riparian zone also adverse affects the amount of large woody debris available for the development of the complex instream features necessary to support pool development and predator protection.

Landowners must apply for coverage under a General Waste Discharge Requirement (WDR) for Discharges Related to Timber Harvest Activities on Non-Federal Land, categorical waiver of WDRs, an individual waiver of WDRs, or a Watershed-wide WDR. Most public lands involved in timber harvest activities within the North Coast Region are under the jurisdiction of the U.S. Forest Service. The Regional Water Board and the USFS entered into a Management Agency Agreement in 1981 to formalize the program that would be implemented to overseeing water quality protection on USFS timber sales. In 2004, the RWB adopted a five-year conditional waiver to regulate USFS timber sales. Forest Service and Regional Water Board staff is currently developing a approach for the Regional Water Board's consideration on the regulatory process that will be used to for both timber sales as well as the other land uses (e.g. road construction and maintenance, grazing, etc) that occur on the USFS holdings.

VIII.2.2.5 401 Certification

Anyone proposing to conduct a project that requires a federal permit or involves dredge or fill activities that may result in a discharge to U.S. surface waters and/or waters of the state are required to obtain a Clean Water Act (CWA) Section 401 Water Quality Certification and/or Waste Discharge Requirements (Dredge/Fill Projects) from the Regional Water Board, verifying that the project activities will comply with state water quality standards. The most common federal permit for dredge and fill activities is a CWA Section 404 permit issued by the Army Corps of Engineers.

Section 401 of the CWA grants each state the right to ensure that the State's interests are protected on any federally permitted activity occurring in or adjacent to waters of the state. In California, the Regional Water Boards are the agency mandated to ensure protection of the State's waters. So if a proposed project requires a U.S. Army Corps of Engineers CWA Section 404 permit, falls under other federal jurisdiction, and has the potential to impact waters of the state, the Regional Water Board will regulate the project and associated activities through a Water Quality Certification determination (Section 401).

However, if a proposed project does not require a federal permit, but does involve dredge or fill activities that may result in a discharge to waters of the state, the Regional Water Board has the option to regulate the project under its state authority in the form of WDRs or a waiver of WDRs. In addition, California Department of Fish and Game (DFG) may regulate the project through the Streambed Alteration Agreement process. DFG issues Streambed Alteration Agreements when project activities have the potential to impact intermittent and perennial streams, rivers, or lakes.

VIII.2.2.6 Total Maximum Daily Loads

The Regional Water Board develops and implements Total Maximum Daily Loads (TMDLs) for water bodies listed as impaired on the 303(d) list. A draft of the 2008 305(b) and 303(d) integrated report is available for public review at http://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/303d/. Waterbodies listed as impaired due to reduced DO include: Lower Eel River, Klamath River, Green Valley Creek in the Russian River watershed, and the Laguna de Santa Rosa in the Russian River watershed. Waterbodies listed as impaired due to elevated nutrients include: Estero Americano and Americano Creek, Stemple Creek and Estero de San Antonio, Butte Valley in the Klamath River watershed, Klamath River, Tule Lake and Mt. Dome Hydrologic Subarea of the Klamath River watershed, and the Laguna de Santa Rosa. The Regional Water Board has approved a TMDL for the DO in the Shasta River, including an implementation plan. USEPA has established a TMDL for nutrients for the Lost River for which no implementation plan yet exists.

The Regional Water Board is responsible for developing and implementing the source control measures necessary to achieve the calculated total maximum daily load allowable to meet water quality objectives as expressed in a TMDL. Because it is concurrently under development with this DO objective revision, the TMDL for the Klamath River is designed to achieve revised DO objectives as described in this staff report.

VIII.2.3 Policies Currently Under Development

The Regional and State Water Boards are in the process of developing a variety of additional policies to address emerging water quality issues confronting the state. Below is a discussion of a few of the policies currently under development that may play a role in the control of activities affecting ambient DO.

VIII.2.3.1 <u>Streams and Wetlands System Protection Policy</u>
Staffs of the North Coast and San Francisco Bay Regional Water Quality Control Boards are developing amendments to their respective Basin Plans that will protect stream and wetlands systems, including measures to protect riparian areas and floodplains. The goals of the proposed Stream and Wetland System Protection Policy are:

- To achieve water quality standards and protect beneficial uses of waters of the state
- To protect drinking water through natural water quality enhancement and protection of groundwater recharge zones
- To restore habitat and protect aquatic species and wildlife
- To enhance flood protection through natural functions of stream and wetlands systems
- To restore the associated recreational opportunities, green spaces and neighborhood amenities that water resources provide
- To protect property values and community welfare by protecting natural environments
- To encourage local watershed planning and support local oversight of water resources
- To improve Regional Water Board permitting and program efficiency

It is the aim of the "Stream and Wetland System Protection Policy" to achieve these goals by protecting and restoring the physical characteristics of stream and wetlands systems—stream channels, wetlands, riparian areas, and floodplains—including their connectivity and natural hydrologic regimes. The Policy will clarify that stream and wetlands system protection and restoration are viable forms of pollution prevention in all land use settings, and that the strategies of pollutant source control and stream and wetlands system protection need to be integrated to complete the entire watershed water quality management strategy. The Policy will be based on sound scientific principles and will develop reasonable methods to protect water quality.

It is staff's intent that a single "Stream and Wetland System Protection Policy" be proposed for Basin Plan adoption in the North Coast and San Francisco Bay Regions to improve regulatory consistency between the two interlocking regions. The Policy may serve as a model for other Regional Water Board's consideration and for the state as a whole in the protection of water quality. The Policy, as envisioned by staff, will promote regulatory efficiency by linking to existing relevant permit conditions and provisions in 401 water quality certifications, timber harvesting plans (THPs), waste discharge requirements (WDRs), WDR waivers, and stormwater National Pollutant Discharge Elimination System (NPDES) permits. The Policy will also promote general efficiency by linking to the Regional Water Boards' monitoring programs (e.g., Surface Water Ambient Monitoring Program) and grants program. The Policy will provide incentives for local jurisdictions to develop watershed management plans that can be used by project applicants to offset impacts to stream and wetlands functions when on-site avoidance of impacts is impossible. In this way the Policy will create a vehicle for working with local jurisdictions to develop effective implementation strategies consistent with local stakeholder interests.

VIII.2.3.2 North Coast Instream Flow Policy

Water Code section 1259.4, which was added by Assembly Bill 2121 (Stats. 2004, ch. 943, §3), requires the State Water Board to adopt principles and guidelines for maintaining instream flows in northern California coastal streams as part of state policy for water quality control, for the purposes of water right administration. The State Water Resources Control Board issued in January 2008 a draft "Policy for Maintaining Instream Flows in Northern California Coastal Streams." The State Water Board held public workshops and received written comment on the draft policy. They are conducting additional technical analysis before finalizing the plan for Board adoption.

As described in the draft:

> "The policy establishes principles and guidelines for maintaining instream flows for the protection of fishery resources. It does not specify the terms and conditions that will be incorporated into water right permits, licenses, and registration. It prescribes protective measures regarding the season of diversion, minimum bypass flow, and maximum cumulative diversion. Site-specific studies may be conducted to evaluate whether alternative protective criteria could be applied. The policy also limits construction of new on stream dams and contains measures to ensure that approval of new on stream dams does not adversely affect instream flows needed for fishery resources. The policy provides for a watershed-based approach to evaluate the effects of multiple diversions on instream flows within a watershed as an alternative to evaluating water diversion projects on an individual basis. Enforcement requirements contained in this policy include a framework for compliance assurance, prioritization of enforcement cases, and descriptions of enforcement actions. The policy contains guidelines for evaluating whether a proposed water diversion, in combination with existing diversions in a watershed, may affect instream flows needed for the protection of fishery resources." (Division of Water Rights 2007)

VIII.2.3.3 Agricultural Waiver Policy

On its webpage, the State Water Board describes the irrigated lands regulatory program as it is implemented in the state, including agricultural waivers (SWRCB 2009).

> "Over the years, the Regional Water Boards issued waivers for over 40 categories of discharges. Although waivers are always conditional, the historic waivers had few conditions. Senate Bill 390, signed into law on October 6, 1999, required the Regional Water Boards to review their existing waivers and to renew them or replace them with WDRs. Under Senate Bill 390, waivers not reissued automatically expired on January 1, 2003.
>
> Discharges from agricultural lands include irrigation return flow, flows from tile drains, and storm water runoff. These discharges can affect water quality by

transporting pollutants including pesticides, sediment, nutrients, salts (including selenium and boron), pathogens, and heavy metals from cultivated fields into surface waters. Many surface water bodies are impaired because of pollutants from agricultural sources. Groundwater bodies have also suffered pesticide, nitrate and salt contamination. Statewide, approximately 9,493 miles of rivers/stream and some 513,130 acres of lake/reservoirs are listed on the 303(d) list as being impaired by irrigated agriculture...

To control and assess the effects of discharges from irrigated agricultural lands, the Los Angeles, Central Coast, Central Valley, and San Diego Regional Water Quality Control Boards have adopted comprehensive conditional waivers. An estimated 80,000 growers, who cultivate over 9 million acres, are subject to conditional waivers in these regions. These Regional Water Boards have made significant strides to implement their waiver programs and are committed to continue their efforts to work with the agricultural community to protect and improve water quality. The number of acres and agricultural operations will increase as other Regional Water Boards adopt conditional waivers for discharges from irrigated agricultural land. Regional Water Boards 1, 2, 6, and 8 have no immediate plans to adopt waivers for agricultural discharges, but may do so eventually to implement TMDLs."

VIII.2.3.4 Prohibition of Excess Sediment

A committee of Regional Water Board members and staff has been developing a Basin Plan amendment designed to control the discharge of excess sediment into waters of the state in the North Coast Region by adopting a Prohibition of Excess Sediment and developing an implementation plan. A copy of the revised draft language is available on the website (http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/sediment_amendment.shtml).

As currently written, the implementation plan calls for the prevention and minimization of any new sources of excess sediment and the inventory, prioritization, control, and monitoring of existing sources of excess sediment. The term excess sediment is currently defined as "soil, rock, and/or sediments (e.g., sand, silt, or clay) discharged to waters of the state in an amount that could be deleterious to beneficial uses or cause a nuisance" (NCRWQCB 2007). The types of anthropogenic activities that could result in a discharge of excess sediment from point or nonpoint sources include but are not limited to: construction; mining; agriculture, including ranching, grazing, and farming; dairies and other types of confined animal operations; road construction, reconstruction, maintenance and decommissioning; timber harvesting; and other earth-disturbing activities.

VIII.2.3.5 Surface Water Rights Program

The Division of Water Rights within the State Boards is responsible for 1) reviewing and issuing permits for the right to appropriate water and 2) maintaining a record of riparian water users (SWRCB 2000). To ensure that water rights decisions do not deleteriously affect water quality in a given region, Water Rights is obligated to ensure that any water right permit it issues complies with the Basin Plan for that region.

The Regional Water Boards establish the beneficial uses[12] of waterbodies within their respective regions and the water quality objectives (e.g., narrative and numeric criteria) necessary to support those beneficial uses. The North Coast Regional Water Board has in the last several years begun to see the availability of adequate instream flows as a critical component of water quality and the protection of beneficial uses. Specifically, the listing of several species of fishes as threatened or endangered under state and federal law has highlighted the need for adequate flows to support the proper functioning of stream and wetland systems; creation and maintenance of high quality habitat; and the stabilization of water quality dynamics. This has led, as an example, to the specific consideration of flow r in the Scott and Shasta River Total Maximum Daily Loads (TMDL) for the protection of instream temperatures threatened by the withdrawal of water from cold water sources. There are other examples, as well, of North Coast streams where the reduction or seasonal loss of instream flows plays a significant role in the listed status of cold water fishes and other beneficial use impairment (e.g., Klamath River). Lastly, there are examples of streams where landscape modifications have increased flows and rates of flooding, also causing impacts to beneficial uses (e.g., Russian River, Freshwater Creek).

VIII.2.3.6 Groundwater Management Program

A discussion of the groundwater management program in the state is included here even though it does not fall under the purview of the State or Regional Water Board. The purpose is to provide a general description of how groundwater resources are managed in the state and to identify opportunities for the Regional Water Board to support activities in the North Coast Region which can result in improved groundwater monitoring and management.

In 2003 the Department of Water Resources issued an update to Bulletin 118 reviewing California's groundwater. Regarding groundwater management in the state, it said:

> "In 1914, California created a system of appropriating surface water rights through a permitting process (Stat 1913, ch. 586), but groundwater use has never been regulated by the State. Though the regulation of groundwater has been considered on several occasions, the California Legislature has repeatedly held that groundwater management should remain a local responsibility (Sax 2002). Although they are treated differently legally, groundwater and surface water are closely interconnected in the hydrologic cycle. Use of one resource will often affect the other, so that effective groundwater management must consider surface water supplies and uses (DWR 2003)."

[12] The term "beneficial use" is used here based on the definition contained in the Porter-Cologne Water Quality Control Act: "Beneficial uses" of the waters of the state that may be protected against quality degradation include but are not limited to, domestic, municipal, agricultural and industrial supply, power generation, recreation, aesthetic enjoyment, navigation and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves. (CWC §13050(f))

Of the many findings, DWR (2003) highlights the fact that 27 counties in California have adopted groundwater ordinances. In all but three cases, restricting out-of-county uses appears to be the only purpose (DWR 2003). An ordinance adopted in Glenn County, however, establishes more comprehensive management objectives. Counties within the North Coast Region for which a groundwater ordinance has been adopted include: Siskiyou, Modoc, Shasta, Glenn, Lake, and Mendocino. North Coast counties for which no groundwater ordinance exists include: Del Norte, Humboldt, Trinity, Sonoma and Marin.

DWR (2003) made ten major recommendations for the purpose of improving the state's management of groundwater resources:

1. Local or regional agencies should develop groundwater management plans if groundwater constitutes part of their water supply.
2. The State of California should continue programs to provide technical and financial assistance to local agencies to develop monitoring programs, management plans, and groundwater storage projects to more efficiently use groundwater resources and provide a sustainable supply for multiple beneficial uses.
3. DWR should continue to work with local agencies to more accurately define historical overdraft and to more accurately predict future water shortages that could result in overdraft.
4. Groundwater management agencies should work with land use agencies to inform them of the potential impacts various land use decisions may have on groundwater, and to identify, prioritize, and protect recharge areas.
5. DWR should publish a report by December 31, 2004 that identifies those groundwater basins or sub basins that are being managed by local or regional agencies and those that are not, and should identify how local agencies are using groundwater resources and protecting groundwater quality.
6. Water managers should include an evaluation of water quality in a groundwater management plan, recognizing that water quantity and water quality are inseparable.
7. Water transfers that involve groundwater (of surface water that will be replaced with groundwater) should be consistent with groundwater management in the source areas that will assure the long term sustainability of the groundwater resource.
8. Continue to support coordinated management of groundwater and surface water supplies and integrated management of groundwater quality and groundwater quantity.
9. Local, State, and federal agencies should improve data collection and analysis to better estimate groundwater basin conditions used in Statewide and local water supply reliability planning.
10. Increase coordination and sharing of groundwater data among local, State, and federal agencies and improve data dissemination to the public.

VIII.3 Recommendations to the Regional Water Board for Implementation

As a result of its analysis of the activities associated with impacts to DO, the regulatory programs currently in place, and the polices under development, staff have identified the following list of general actions as necessary to achieve ambient DO water quality objectives.

1. Update the DO limits contained in all NPDES permits and WDRs with the new DO objectives when the permits come up for renewal. Calculate DO limits for all new NPDES permits and WDRS based on the revised DO objectives. Ensure permit writers are familiar with the basis for the DO objective revisions.
2. Implement all approved nutrient and DO TMDLs as they are currently written. Following implementation and based on adaptive monitoring results, consider updating approved nutrient and DO TMDLs based on revised DO objectives, as appropriate. All DO and nutrient TMDLs under development and yet to be developed must be based on the revised DO objectives.
3. Continue implementing the "Plan for California's Nonpoint Source Pollution Control Program" with emphasis on management measures specific to agriculture; forestry; urban areas; marinas and recreational boating; hydromodification; and wetlands, riparian areas and vegetated treatment systems. Ensure staff in the Nonpoint Source Unit is familiar with the basis for the DO revisions.
4. Only provide 401 Certification to those projects demonstrating an ability to meet new ambient water quality objectives for DO. Ensure staff responsible for 401 certifications is familiar with the basis for the DO revisions.
5. Prioritize the identification and permitting (or removal) of currently unpermitted instream impoundments.
6. Support the finalization and adoption of the "Stream and Wetland System Protection Policy," including adoption of a narrative objective and implementation measures for the protection of the pattern and range of flows necessary to protect beneficial uses. If the Regional Water Board does not elect to adopt the policy as developed by staff in its entirety, staff recommends the Regional Water Board consider adoption of the narrative objective and implementation measures for flow.
7. Support the finalization and adoption of the "North Coast Instream Flow Policy," including protective measures regarding the season of diversion, minimum bypass flow, and maximum cumulative diversion. Continue to provide guidance to State Water Board staff on compliance with the Basin Plan, including protection from further impairment in 303(d) listed streams and enforcement of the policy for unpermitted water diverters. If the policy is not adopted by the State Water Board, staff recommends the issue be considered as a priority issue for the North Coast Board during the next Triennial Review process.
8. Prioritize the development of an agricultural policy including development of a general WDR and companion conditional waiver to address issues of chemical, organic matter, and nutrient loading; discharge of agricultural return flows; and stream channel, stream bank and riparian zone protections from activities such as water diversion, grazing, planting/harvesting, irrigation, and road building.

9. Support the finalization and adoption of the "Prohibition of Excess Sediment" at either the region wide or watershed scale, including measures to prevent and minimize new sources of sediment and inventory, prioritize, control, and monitor existing sources of excess sediment. The policy should be brought before the Regional Water Board for their consideration before the end of the 2007-2010 Triennial Review period.
10. Support the conduct of local research regarding the relationship between groundwater basins and surface water basins in the North Coast Region, including basin delineation, flow data, water quality data, and water use information. Review the existing groundwater management plans in Siskiyou, Modoc, Shasta, Glenn, Lake and Mendocino counties. Develop a strategy for protecting surface water quality from impairment due to the loss or alteration of cold groundwater inputs to North Coast rivers. Encourage Del Norte, Humboldt, Trinity, Sonoma and Marin counties to develop groundwater management plans.
11. Prioritize for grant funding projects that demonstrate management techniques in concert with those described in Section VIII.1.

In addition, staff have identified a series of specific management measures, as adapted from the Shasta River TMDL Implementation Plan and included in Table 4 that could be implemented by land managers and others.

Table 4: Implementation Measures for Land Managers and Others

Responsible Party	**Actions to Achieve Revised Ambient Dissolved Oxygen Water Quality Objectives**
	Range and Riparian Land Management
Parties conducting grazing activities	Landowners should employ land stewardship practices and activities that minimize, control, and preferably prevent discharges of fine sediment, nutrients, and other oxygen consuming materials to waters of the North Coast Region. Landowners should also employ land stewardship practices and activities that minimize, control, and preferably prevent elevated solar radiation loads from affecting waters of the North Coast rivers and their tributaries. Those that oversee and manage grazing and range land activities in the North Coast Region should implement the applicable management measures for agriculture and grazing from the following sources: • *Policy for the Implementation and Enforcement of the Nonpoint* Source *Pollution Control Program* (NPS Policy) (SWRCB 2004 or as amended). • Recovery *Strategy for California Coho Salmon* (Coho Recovery Strategy) (CDFG 2004)
Natural Resource Conservation Service (NRCS) and Resource Conservation Districts (RCDs)	Assist landowners and mangers in developing and implementing management practices that minimize, control and preferably prevent discharges of fine sediment, nutrients and other oxygen consuming materials, as well as elevated solar radiation loads from affecting waters of the North Coast Region. Assist landowners in developing and implementing a monitoring program to evaluate and document implementation and effectiveness of the range and riparian management actions taken by the landowner.
California Department of Fish and Game (CDFG)	Assist landowners in developing and implementing management practices that minimize, control, and preferably prevent discharges of fine sediment, nutrients and other oxygen consuming materials as well as elevated solar radiation loads from affecting waters of the North Coast. Administer the Coho Recovery Strategy.
North Coast Regional Water Quality Control Board (Regional Water Board)	Work cooperatively with the Natural Resources Conservation Service and Resource Conservation Districts to develop appropriate management plans, identify grant funding, and support public outreach efforts. The Regional Water Board shall address the removal and suppression of vegetation that provides shade to a water body through development of a Stream and Wetland System Protection Policy. This will be a comprehensive, region-wide riparian policy that will address the importance of shade on instream water temperatures and will potentially propose riparian setbacks and buffer widths. The Policy will likely propose new regulations and guidelines, and will therefore take the form of an amendment to the Basin Plan. Other actions under this section may be modified for consistency with this policy, once adopted. With funding already available through a grant from the U.S. EPA, Regional Water Board staff is scheduled to develop this Policy for Regional Water Board consideration by the end of the 2007-2010 Triennial Review period.. The Regional Water Board shall take appropriate permitting actions as necessary to address the removal and suppression of vegetation that provides

Responsible Party	Actions to Achieve Revised Ambient Dissolved Oxygen Water Quality Objectives
	shade to a water body in the North Coast Region. Such actions may include, but are not limited to, prohibitions, waste discharge requirements (WDRs) or waivers of WDRs for grazing and rangeland activities, farming activities near water bodies, stream bank stabilization activities, and other land uses that may remove and/or suppress vegetation that provides shade to a water body.
	Tailwater Return Flows
Irrigators	Those that oversee and manage tailwater discharges from irrigated lands in North Coast rivers and tributaries, which may include landowners, lessees, and land managers (collectively referred to as irrigators), should employ land stewardship and irrigation management practices and activities that minimize, control, and preferably prevent discharges of fine sediment, nutrients and other oxygen consuming materials, and elevated water temperatures from affecting waters of the North Coast Region. Irrigators should implement the applicable management measures for tailwater return flows from the following sources: • Policy *for the Implementation and Enforcement of the Nonpoint Source Pollution Control Program* (NPS Policy) (SWRCB 2004 or as amended). • *Recovery Strategy for California Coho Salmon* (Coho Recovery Strategy) (CDFG 2004). In addition, landowners may develop and implement management measures suitable for their site-specific conditions.
NRSC and RCDs	Assist irrigators in developing and implementing management practices that minimize, control and preferably prevent discharges of fine sediment, nutrients and other oxygen consuming materials, and elevated water temperatures from affecting waters of the North Coast Region.
CDFG	Assist irrigators in developing and implementing management practices that minimize, control, and preferably prevent discharges of fine sediment, nutrients and other oxygen consuming materials, and elevated water temperatures from affecting waters of the North Coast Region. Administer the Coho Recovery Strategy.
Regional Water Boards	Evaluate the effectiveness of tailwater management actions and develop recommendations for the most effective regulatory vehicle to bring tailwater discharges into compliance with water quality standards, the TMDLs, and the NPS Policy. Should efforts fail to be implemented or effective, the Regional Water Board's Executive Officer may require irrigators, on a site specific as-needed basis, to develop, submit, and implement, upon review, comment and approval by the Regional Water Board's Executive Officer, a tailwater management plan designed to prevent discharges of fine sediment, nutrients and other oxygen consuming materials, and elevated solar radiation loads from affecting waters of the Shasta River and its tributaries.
	Water Use and Flow
Water Diverters	Water diverters should employ water management practices and activities that

Responsible Party	Actions to Achieve Revised Ambient Dissolved Oxygen Water Quality Objectives
	result in increased **dedicated cold water instream flow** in the rivers and tributaries of the North Coast Region. Water diverters should participate in and implement applicable flow-related measures outlined in the following sources: • *Policy for the Implementation and Enforcement of the Nonpoint Source Pollution Control Program* (NPS Policy) (SWRCB 2004 or as amended). • Recovery *Strategy for California Coho Salmon* (Coho Recovery Strategy) (CDFG 2004). This recommended flow measure does not alter or reallocate water rights within the North Coast Region's waterbodies, nor does it bind the Regional Water Board in future TMDLs, the State Water Board's Division of Water Rights in any water rights decision, or state and federal courts.
NRSC and RCDs	Assist water diverters in developing and implementing management practices that increase dedicated cold water instream flows in the North Coast Region.
CDFG	Assist water diverters in developing and implementing management practices that increase dedicated cold water instream flows in the North Coast Region. Administer the Coho Recovery Strategy.
Regional Water Board	Work cooperatively with water diverters, RCDs, CDFG and DWR, wholly or in part, to establish monitoring and reporting programs to gauge implementation and effectiveness of the actions taken by responsible parties.
Irrigation Control Structures, Flashboard Dams, and other Minor Impoundments (Collectively referred to as minor impoundments)	
Individual Irrigators Irrigation Districts Department of Water Resources (DWR) Others owning, operating, managing, or anticipating construction of minor impound	Irrigation districts, individual irrigators, and others that own, operate, manage, or anticipate constructing instream minor impoundments or other structures capable of blocking, impounding, or otherwise impeding the free flow of water in the North Coast Region shall comply with one or more of the following measures: • Permanently remove minor impoundments • Re-engineer existing impoundments to decrease surface area of impoundment. • Not construct new impoundments unless they can be shown to have positive effects to the beneficial uses of Individual Irrigators
NRSC and RCDs	Assist in developing and implementing minor impoundment removal, re-engineering or initial design work for compliance with water quality standards, the TMDLs, and the NPS Policy.
CDFG	Assist in developing and implementing the removal, re-engineering, or limitation on the construction of minor impoundments in the North Coast Region. Administer the Coho Recovery Strategy.
Regional Water Boards	Work with CDFG to establish monitoring and reporting elements of their programs in order to gage their effectiveness. Include appropriate conditions in Clean Water Act water quality certification permits for minor impoundment removal or re-engineering activities that comply with water quality standards, the TMDL, and the NPS Policy.
Urban and Suburban Runoff	

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Cities Other landowners with suburban runoff	Cities and other landowners with suburban runoff should implement the applicable measures from the NPS Policy.
RWQCB	Work cooperatively with responsible parties to implement their plan, including appropriate management measures and reasonable time schedules which minimize, control, and preferably prevent discharges of fine sediment, nutrients and other oxygen consuming materials and elevated temperature waste discharge from affecting waters of the North Coast Region.
Activities on Federal Lands	
USFS	The USFS shall consistently implement the best management practices for timber harvest activities, grazing, and other activities included in the: • *Water Quality Management for Forest System Lands in California, Best Management Practices* (USFS 2000) or as amended as long as equivalent or better water quality protections are required.
Regional Water Board	Continue its involvement with the USFS to periodically reassess the mutually agreed upon goals of the 1981 Management Agency Agreement between the SWRCB and the USFS. Work with the USFS to draft and finalize a regulatory program (WDR/conditional waiver).
BLM	BLM shall implement best management grazing strategies that are detailed in a joint management agency document titled: • Riparian Management, TR 1737-14, Grazing Management for Riparian-Wetland Areas, USDI-BLM, USDA-FS (1997).
Regional Water Board	The Regional Water Board will work with the BLM to draft and finalize a WDR/conditional waiver.
Timber Harvest Activities on Non-Federal Lands	
Private parties conducting timber harvest	Parties conducting timber harvest activities should employ land stewardship practices that minimize, control, and preferably prevent discharges of fine sediment, nutrients and other oxygen consuming materials from affecting waters of the North Coast Region. Landowners should also employ land stewardship practices and activities that prevent to the maximum extent possible, elevated solar radiation loads from affecting waters of the North Coast Region's rivers and their Class I[13] and Class II tributaries[14].
CDF	Ensure timber operations in the North Coast Region are in compliance with the water quality standards, the TMDLs, and NPS Policy.
Regional Water Boards	The Regional Water Board shall use appropriate permitting and enforcement tools to regulate discharges from timber harvest activities in the North Coast Region, including, but not limited to: Participation in the CDF timber harvest review and approval process.

[13] A Class I stream is watercourse which contains domestic water supplies including springs on site and/or within 100 feet downstream of the operation area and/or have fish always or seasonally present onsite, including habitat to sustain fish migration and spawning. Class I streams include historically fish-bearing streams.

[14] A Class II stream is a watercourse which has fish always or seasonally present offsite within 1000 feet downstream; and/or contains aquatic habitat for non-fish aquatic species. Class II waters do not include Class III waters that are directly tributary to Class I waters.

Responsible Party	Actions to Achieve Revised Ambient Dissolved Oxygen Water Quality Objectives
	Use of general or specific WDRs and waivers of WDRs, if applicable, to regulate timber harvest activities on private lands in the North Coast Region. If the California Forest Practice Rules (Title 14 CCR Chapters 4, 4.5 and 10) are changed in a manner that reduces water quality protections, the Regional Water Board shall require plan submitters to maintain the level of water quality protection provided by the 2006 Forest Practice Rules.
California Department of Transportation Activities	
CalTrans	Caltrans shall implement the requirements of its stormwater program.
Regional Water Board	Complete an initial evaluation of the Caltrans Stormwater Program. Continue periodic reviews of the program to assure ongoing compliance.

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APPENDIX A

pH

The pH shall conform to those limits listed in Table 3-1. For waters not listed in Table 3-1 and where pH objectives are not prescribed, the pH shall not be depressed below 6.5 nor raised above 8.5. Changes in normal ambient pH levels shall not exceed 0.2 units in waters with designated marine (MAR) or saline (SAL) beneficial uses nor 0.5 units within the range specified above in fresh waters with designated COLD or WARM beneficial uses.

Dissolved Oxygen

Dissolved oxygen concentrations shall conform to those limits listed in Table 3-1. For waters not listed in Table 3-1 and where dissolved oxygen objectives are not prescribed the dissolved oxygen concentrations shall not be reduced below the following minimum levels at any time.

Waters designated WARM, MAR, or SAL ..... 5.0 mg/l
Waters designated COLD .... 6.0 mg/l
Waters designated SPWN.............................. 7.0 mg/l
Waters designated SPWN during critical spawning and egg incubation periods .... 9.0 mg/l

Bacteria

The bacteriological quality of waters of the North Coast Region shall not be degraded beyond natural background levels. In no case shall coliform concentrations in waters of the North Coast Region exceed the following:

In waters designated for contact recreation (REC-1), the median fecal coliform concentration based on a minimum of not less than five samples for any 30-day period shall not exceed 50/100 ml, nor shall more than ten percent of total samples during any 30-day period exceed 400/100 ml (State Department of Health Services).

At all areas where shellfish may be harvested for human consumption (SHELL), the fecal coliform concentration throughout the water column shall not exceed 43/100 ml for a 5-tube decimal dilution test or 49/100 ml when a three-tube decimal dilution test is used (National Shellfish Sanitation Program, Manual of Operation).

Temperature

Temperature objectives for COLD interstate waters, WARM interstate waters, and Enclosed Bays and Estuaries are as specified in the "Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays of California" including any revisions thereto. A copy of this plan is included verbatim in the Appendix Section of this Plan. In addition, the following temperature objectives apply to surface waters:

The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses.

At no time or place shall the temperature of any COLD water be increased by more than 5°F above natural receiving water temperature.

At no time or place shall the temperature of WARM intrastate waters be increased more than 5°F above natural receiving water temperature.

Toxicity

All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, bioassays of appropriate duration, or other appropriate methods as specified by the Regional Water Board.

The survival of aquatic life in surface waters subjected to a waste discharge, or other controllable water quality factors, shall not be less than that for the same water body in areas unaffected by the waste discharge, or when necessary for other control water that is consistent with the requirements for "experimental water" as described in "**Standard Methods for the Examination of Water and Wastewater**", 18th Edition (1992). As a minimum, compliance with this objective as stated in the previous sentence shall be evaluated with a 96-hour bioassay.

In addition, effluent limits based upon acute bioassays of effluents will be prescribed. Where appropriate, additional numerical receiving water objectives for specific toxicants will be established as sufficient data become available, and source control of toxic substances will be encouraged.

TABLE 3-1

SPECIFIC WATER QUALITY OBJECTIVES FOR NORTH COAST REGION

	Specific Conductance (micromhos) @ 77°F		Total Dissolved Solids (mg/l)		Dissolved Oxygen (mg/l)			Hydrogen Ion (pH)		Hardness (mg/l)	Boron (mg/l)	
Waterbody[1]	90% Upper Limit[3]	50% Upper Limit[2]	90% Upper Limit[3]	50% Upper Limit[2]	Min	90% Lower Limit[3]	50% Lower Limit[2]	Max	Min	50% Upper Limit[2]	90% Upper Limit[3]	50% Upper Limit[2]
Lost River HA												
Clear Lake Reservoir & Upper Lost River	300	200			5.0		8.0	9.0	7.0	60	0.5	0.1
Lower Lost River	1000	700			5.0		-	9.0	7.0	-	0.5	0.1
Other Streams	250	150			7.0		8.0	8.4	7.0	50	0.2	0.1
Tule Lake	1300	900			5.0		-	9.0	7.0	400	-	-
Lower Klamath Lake	1150	850			5.0		-	9.0	7.0	400	-	-
Groundwaters[4]	1100	500			-		-	8.5	7.0	250	0.3	0.2
Butte Valley HA												
Streams	150	100			7.0		9.0	8.5	7.0	30	0.1	0.0
Meiss Lake	2000	1300			7.0		8.0	9.0	7.5	100	0.3	0.1
Groundwaters[4]	800	400			-		-	8.5	6.5	120	0.2	0.1
Shasta Valley HA												
Shasta River	800	600			7.0		9.0	8.5	7.0	220	1.0	0.5
Other Streams	700	400			7.0		9.0	8.5	7.0	200	0.5	0.1
Lake Shastina	300	250			6.0		9.0	8.5	7.0	120	0.4	0.2
Groundwaters[4]	800	500			-		-	8.5	7.0	180	1.0	0.3
Scott River HA												
Scott River	350	250			7.0		9.0	8.5	7.0	100	0.4	0.1
Other Streams	400	275			7.0		9.0	8.5	7.0	120	0.2	0.1
Groundwaters[4]	500	250			-		-	8.0	7.0	120	0.1	0.1
Salmon River HA												
All Streams	150	125			9.0		10.0	8.5	7.0	60	0.1	0.0
Middle Klamath River HA												
Klamath River above Iron Gate Dam including Iron Gate & Copco Reservoirs	425	275			7.0		10.0	8.5	7.0	60	0.3	0.2
Klamath River below Iron Gate Dam	350	275			8.0		10.0	8.5	7.0	80	0.5	0.2
Other Streams	300	150			7.0		9.0	8.5	7.0	60	0.1	0.0
Groundwaters[4]	750	600			-		-	8.5	7.5	200	0.3	0.1
Applegate River HA												
All Streams	250	175			7.0		9.0	8.5	7.0	60	-	-
Upper Trinity River HA												
Trinity River[5]	200	175			7.0		10.0	8.5	7.0	80	0.1	0.0
Other Streams	200	150			7.0		10.0	8.5	7.0	60	0.0	0.0
Clair Engle Lake and Lewiston Reservoir	200	150			7.0		10.0	8.5	7.0	60	0.0	0.0

TABLE 3-1 (CONTINUED)

SPECIFIC WATER QUALITY OBJECTIVES FOR NORTH COAST REGION

	Specific Conductance (micromhos) @ 77°F		Total Dissolved Solids (mg/l)		Dissolved Oxygen (mg/l)			Hydrogen Ion (pH)		Hardness (mg/l)	Boron (mg/l)	
Waterbody[1]	90% Upper Limit[3]	50% Upper Limit[2]	90% Upper Limit[3]	50% Upper Limit[2]	Min	90% Lower Limit[3]	50% Lower Limit[2]	Max	Min	50% Upper Limit[2]	90% Upper Limit[3]	50% Upper Limit[2]
Hayfork Creek												
Hayfork Creek	400	275			7.0		9.0	8.5	7.0	150	0.2	0.1
Other Streams	300	250			7.0		9.0	8.5	7.0	125	0.0	0.0
Ewing Reservoir	250	200			7.0		9.0	8.0	6.5	150	0.1	0.0
Groundwaters [4]	350	225			-		-	8.5	7.0	100	0.2	0.1
S.F. Trinity River HA												
S.F. Trinity River	275	200			7.0		10.0	8.5	7.0	100	0.2	0.0
Other Streams	250	175			7.0		9.0	8.5	7.0	100	0.0	0.0
Lower Trinity River HA												
Trinity River	275	200			8.0		10.0	8.5	7.0	100	0.2	0.0
Other Streams	250	200			9.0		10.0	8.5	7.0	100	0.1	0.0
Groundwaters [4]	200	150			-		-	8.5	7.0	75	0.1	0.1
Lower Klamath River HA												
Klamath River	300[6]	200[6]			8.0		10.0	8.5	7.0	75[6]	0.5[6]	0.2[6]
Other Streams	200[6]	125[6]			8.0		10.0	8.5	6.5	25[6]	0.1[6]	0.0[6]
Groundwaters [4]	300	225			-		-	8.5	6.5	100	0.1	0.0
Illinois River HA												
All Streams	200	125			8.0		10.0	8.5	7.0	75	0.1	0.0
Winchuck River HU												
All Streams	200[6]	125[6]			8.0		10.0	8.5	7.0	50[6]	0.0[6]	0.0[6]
Smith River HU												
Smith River-Main Forks	200	125			8.0		11.0	8.5	7.0	60	0.1	0.1
Other Streams	150[6]	125[6]			7.0		10.0	8.5	7.0	60[6]	0.1[6]	0.0[6]
Smith River Plain HSA												
Smith River	200[6]	150[6]			8.0		11.0	8.5	7.0	60[6]	0.1[6]	0.0[6]
Other Streams	150[6]	125[6]			7.0		10.0	8.5	6.5	60[6]	0.1[6]	0.0[6]
Lakes Earl & Talawa	-	-			7.0		9.0	8.5	6.5	-	-	-
Groundwaters [4]	350	100			-		-	8.5	6.5	75	1.0	0.0
Crescent City Harbor	-	-										
Redwood Creek HU												
Redwood Creek	220[6]	125[6]	115[6]	75[6]	7.0	7.5	10.0	8.5	6.5			
Mad River HU												
Mad River	300[6]	150[6]	160[6]	90[6]	7.0	7.5	10.0	8.5	6.5			
Eureka Plain HU												
Humboldt Bay	-	-	-	-	6.0	6.2	7.0	8.5	7			
Eel River HU												
Eel River	375[6]	225[6]	275[6]	140[6]	7.0	7.5	10.0	8.5	6.5			
Van Duzen River	375	175	200	100	7.0	7.5	10.0	8.5	6.5			

TABLE 3-1 (CONTINUED)

SPECIFIC WATER QUALITY OBJECTIVES FOR NORTH COAST REGION

Waterbody[1]	Specific Conductance (micromhos) @ 77°F 90% Upper Limit[3]	Specific Conductance 50% Upper Limit[2]	Total Dissolved Solids (mg/l) 90% Upper Limit[3]	Total Dissolved Solids 50% Upper Limit[2]	Dissolved Oxygen (mg/l) Min	Dissolved Oxygen 90% Lower Limit[3]	Dissolved Oxygen 50% Lower Limit[2]	Hydrogen Ion (pH) Max	Hydrogen Ion (pH) Min	Hardness (mg/l) 50% Upper Limit[2]	Boron (mg/l) 90% Upper Limit[3]	Boron (mg/l) 50% Upper Limit[2]
South Fork Eel River	350	200	200	120	7.0	7.5	0.0	8.5	6.5			
Middle Fork Eel River	450	200	230	130	7.0	7.5	10.0	8.5	6.5			
Outlet Creek	400	200	230	125	7.0	7.5	10.0	8.5	6.5			
Cape Mendocino HU												
Bear River	390[6]	255[6]	240[6]	150[6]	7.0	7.5	10.0	8.5	6.5			
Mattole River	300[6]	170[6]	170[6]	105[6]	7.0	7.5	10.0	8.5	6.5			
Mendocino Coast HU												
Ten Mile River	-	-	-	-	7.0	7.5	10.0	8.5	6.5			
Noyo River	185[6]	150[6]	120[6]	105[6]	7.0	7.5	10.0	8.5	6.5			
Jug Handle Creek	-	-	-	-	7.0	7.5	10.0	8.5	6.5			
Big River	300[6]	195[6]	190[6]	130[6]	7.0	7.5	10.0	8.5	6.5			
Albion River	-	-	-	-	7.0	7.5	10.0	8.5	6.5			
Navarro River	285[6]	250[6]	170[6]	150[6]	7.0	7.5	10.0	8.5	6.5			
Garcia River	-	-	-	-	7.0	7.5	10.0	8.5	6.5			
Gualala River	-	-	-	-	7.0	7.5	10.0	8.5	6.5			
Russian River HU												
(upstream)[8]	320	250	170	150	7.0	7.5	10.0	8.5	6.5			
(downstream)[9]	375[6]	285[6]	200[6]	170[6]	7.0	7.5	10.0	8.5	6.5			
Laguna de Santa Rosa	-	-	-	-	7.0	7.5	10.0	8.5	6.5			
Bodega Bay	-	-	-	-	6.0	6.2	7.0	8.5	7			
Coastal Waters[10]	-	-	-	-	11	11	11	12	12			

1 Water bodies are grouped by hydrologic unit (HU), hydrologic area (HA), or hydrologic subarea (HSA).
2 50% upper and lower limits represent the 50 percentile values of the monthly means for a calendar year. 50% or more of the monthly means must be less than or equal to an upper limit and greater than or equal to a lower limit.
3 90% upper and lower limits represent the 90 percentile values for a calendar year. 90% or more of the values must be less than or equal to an upper limit and greater than or equal to a lower limit.
4 Value may vary depending on the aquifer being sampled. This value is the result of sampling over time, and as pumped, from more than one aquifer.
5

Daily Average Not to Exceed	Period	River Reach
60°F	July 1 - Sept. 14	Lewiston Dam to Douglas City Bridge
56°F	Sept. 15 - Oct. 1	Lewiston Dam to Douglas City Bridge
56°F	Oct. 1 - Dec. 31	Lewiston Dam to confluence of North Fork Trinity River

6 Does not apply to estuarine areas.
7 pH shall not be depressed below natural background levels.
8 Russian River (upstream) refers to the mainstem river upstream of its confluence with Laguna de Santa Rosa.
9 Russian River (downstream) refers to the mainstem river downstream of its confluence with Laguna de Santa Rosa.
10 The State's Ocean Plan applies to all North Coast Region coastal waters.
11 Dissolved oxygen concentrations shall not at any time be depressed more than 10 percent from that which occurs naturally.
12 pH shall not be changed at any time more than 0.2 units from that which occurs naturally.
\- no water body specific objective available.

APPENDIX B

TABLE 2-1: BENEFICIAL USES OF WATERS OF THE NORTH COAST REGION

HU/HA/ HSA	HYDROLOGIC UNIT/AREA/ SUBUNIT/DRAINAGE FEATURE	BENEFICIAL USES																										
		MUN	AGR	IND	PRO	GWR	FRSH	NAV	POW	REC1	REC2	COMM	WARM	COLD	ASBS	SAL	WILD	RARE	MAR	MIGR	SPWN	SHELL	EST	AQUA	CUL	FLD	WET	WQE
101.00	**Winchuck River Hydrologic Unit**																											
	Winchuck River	E	E	E	P		E	E	P	E	E	E		E			E	E		E	E			P				
102.00	**Rogue River Hydrologic Unit**																											
102.20	Ilinois River Hydrologic Area	E	E	E	P		E	E	E	E	E	E		E			E	E		E	E			E				
102.30	Applegate River Hydrologic Area	E	E	E	E		E	E	P	E	E	E		E			E	E		E	E			P				
103.00	**Smith River Hydrologic Unit**																											
103.10	Lower Smith River Hydrologic Area																											
103.11	Smith River Plain Hydrologic Subarea	E	E	E	P		E	E		E	E	E		E			E	E	E	E	E		E	P	E			
	Lake Talawa	P					E	E		E	E	E	E	E			E	E		E				P	E			
	Lake Earl	E	E	E			E	E		E	E	E	E	E			E	E		E				P	E			
	Crescent City Harbor						E	E		E	E	E	P	E			E	E	E	E		E		E				
103.12	Rowdy Creek Hydrologic Subarea	E	E	E	P		E	E	P	E	E	E		E			E	E		E	E			P				
103.13	Mill Creek Hydrologic Subarea	E	E	E	P		E	E	P	E	E	E		E			E	E		E	E			P				
103.20	South Fork Smith River Hydrologic Area	E	E	E	P		E	E	E	E	E	E		E			E	E		E	E			P	E			
103.30	Middle Fork Smith River Hydrologic Area	E	E	E	P		E	E	E	E	E	E		E			E	E		E	E			E	P			
103.40	North Fork Smith River Hydrologic Area	E	E	E	P		E	E	E	E	E	E		E			E	E		E	E			P				
103.50	Wilson Creek Hydrologic Area	E	E	E	P		E	E	E	E	E	E		E			E	E		E	E			P	E			
105.00	**Klamath River Hydrologic Unit**																											
105.10	Lower Klamath River Hydrologic Area																											
105.11	Klamath Glen Hydrologic Subarea	E	E	P	P	E	E	E	P	E	E	E	E	E			E	E	E	E	E	E	E	P	E			
105.12	Orleans Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E	E	E			E	E		E	E	P		P	E			
105.20	Salmon River Hydrologic Area																											
105.21	Lower Salmon Hydrologic Subarea	E	E	E	P		E	E	P	E	E	E		E			E	E		E	E	P		P	E			
105.22	Wooley Creek Hydrologic Subarea	E	P	E	P	E	E	E	P	E	E	E		E			E	E		E	E	P		P	E			
105.23	Sawyers Bar Hydrologic Subarea	E	E	E	P		E	E	P	E	E	E		E			E	E		E	E	P		P				
105.24	Cecilville Hydrologic Subarea	E	E	E	P		E	E	P	E	E	E		E			E	E		E	E	P		P				

TABLE 2-1: BENEFICIAL USES OF WATERS OF THE NORTH COAST REGION

HU/HA/ HSA	HYDROLOGIC UNIT/AREA/ SUBUNIT/DRAINAGE FEATURE	BENEFICIAL USES																										
		MUN	AGR	IND	PRO	GWR	FRSH	NAV	POW	REC1	REC2	COMM	WARM	COLD	ASBS	SAL	WILD	RARE	MAR	MIGR	SPWN	SHELL	EST	AQUA	CUL	FLD	WET	WQE
105.30	Middle Klamath River Hydrologic Area																											
105.31	Ukonom Hydrologic Subarea	E	E	E	E	E	E	E	P	E	E	E	E	E			E	E		E	E			P	E			
105.32	Happy Camp Hydrologic Subarea	E	E	E	E	E	E	E	P	E	E	E	E	E			E	E		E	E			P	E			
105.33	Seiad Valley Hydrologic Subarea	E	E	E	E	E	E	E	P	E	E	E	E	E			E	E		E	E			P	E			
105.35	Beaver Creek Hydrologic Subarea	E	E	E	E	E	E	E	P	E	E	E	E	E			E	E		E	E			P				
105.36	Hornbrook Hydrologic Subarea	E	E	E	E	E	E	E	P	E	E	E	E	E			E	E		E	E			P				
105.37	Iron Gate Hydrologic Subarea	P	P	P	P		E	E	E	E	E	E	E	E			E	E		E	E	E		E				
105.38	Copco Lake Hydrologic Subarea	E	E	E	P		E	E	E	E	E	E	E	E			E	E		E	E			E				
105.40	Scott River Hydrologic Area																											
105.41	Scott Bar Hydrologic Subarea	E	E	E	P	E	E	E	E	E	E	E		E			E	E		E	E			P				
105.42	Scott Valley Hydrologic Subarea	E	E	E	P	E	E	E	E	E	E	E		E			E	E		E	E			E				
105.50	Shasta Valley Hydrologic Area																											
	Shasta River & Tributaries	E	E	E	P	E	E	E	P	E	E	E	E	E			E	E		E	E			E				
	Lake Shastina	P	E	P	P	E	E	E		E	E		E	E			E			P				P				
	Lake Shastina Tributaries	E	E	E	P	E	E	P	P	E	E	E	E	E			E			E	E			P				
105.80	Butte Valley Hydrologic Area																											
105.81	Macdoel-Dorris Hydrologic Subarea	E	E	P	P				E	E	E	E	E	E			E	E		E	E			P				
	Meiss Lake	E	E	P	P	E				P	E		E	E			E							P				
105.82	Bray Hydrologic Subarea	E	E						P	E	E	E	E				E	E		E	E			P				
105.83	Tennant Hydrologic Subarea	E	E	P	P	E	E		P	E	E	P	P	E			E	P		E	E			P				

TABLE 2-1: BENEFICIAL USES OF WATERS OF THE NORTH COAST REGION

HU/HA/ HSA	HYDROLOGIC UNIT/AREA/ SUBUNIT/DRAINAGE FEATURE	BENEFICIAL USES																										
		MUN	AGR	IND	PRO	GWR	FRSH	NAV	POW	REC1	REC2	COMM	WARM	COLD	ASBS	SAL	WILD	RARE	MAR	MIGR	SPWN	SHELL	EST	AQUA	CUL	FLD	WET	WQE
105.90	Lost River Hydrologic Area																											
105.91	Mount Dome Hydrologic Subarea	P	E	P	P	E	E		P	P	E	P	E	E			E	E		E	E			P				
105.92	Tule Lake Hydrologic Subarea	P	E	P	P	E	E			P	E	E	E	P			E	E		E	E			P				
105.93	Clear Lake Hydrologic Subarea	P	E	P	P	E	E	P	P	E	E	E	E	E			E	E		E	E	P		P				
105.94	Boles Hydrologic Subarea	P	E	P	P	E	E		P	P	E	E	E	E			E	E		E	E	P		P				
	Trinity River Hydrologic Unit																											
106.10	Lower Trinity River Hydrologic Area																											
106.11	Hoopa Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E	P		P	E			
106.12	Willow Creek Hydrologic Subarea	E	E	E	P	E	E	E	E	E	E	E		E			E	E		E	E	P		P				
106.13	Burnt Ranch Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E	P		E				
106.14	New River Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E	P		P				
106.15	Helena Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E	P		P				
106.20	South Fork Trinity River Hydrologic Area																											
106.21	Grouse Creek Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E			P				
106.22	Hyampom Hydrologic Subarea	E	E	E	P	E	E	P	E	E	E	E		E			E	E		E	E			P				
106.23	Forest Glen Hydrologic Subarea	E	E	E	P	E	E	P	P	E	E	E		E			E	E		E	E			P				
106.24	Corral Creek Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E			P				
106.25	Hayfork Valley Hydrologic Subarea	E	E	E	E	E	E		P	E	E	E		E			E	E		E	E			P				
	Ewing Reservoir	E		P	P			E		P	E	E	E	E			E	E						P				
106.30	**Middle Trinity Hydrologic Area**																											
106.31	Douglas City Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E			P				
106.32	Weaver Creek Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E			E				

TABLE 2-1: BENEFICIAL USES OF WATERS OF THE NORTH COAST REGION

HU/HA/ HSA	HYDROLOGIC UNIT/AREA/ SUBUNIT/DRAINAGE FEATURE	BENEFICIAL USES																									
		MUN	AGR	IND	PRO	GWR	FRSH	NAV	POW	REC1	REC2	COMM	WARM	COLD	ASBS	SAL	WILD	RARE	MAR	MIGR	SPWN	SHELL	EST	AQUA	CUL	FLD	WET	WQE
106.40	Upper Trinity River Hydrologic Area																											
	Trinity Lake (formerly Clair Engle Lake)	E	E	E	E	E	E	E	E	E	E	E	E	E			E	E		P	E			P				
	Lewiston Reservoir	E	E	P	P	E	E	E	E	E	E	E	P	E			E	E		P	E			E				
	Trinity River	E	E	P	P	E	E	E	P	E	E	E		E			E	E		E	E			E				
107.00	**Redwood Creek Hydrologic Unit**																											
107.10	Orick Hydrologic Area	E	E	E	P	E		E	P	E	E	E		E			E	E	E	E	E		E	P	E			
107.20	Beaver Hydrologic Area	E	E	E	P	E		E	P	E	E	E		E			E	E		E	E			P				
107.30	Lake Prairie Hydrologic Area	E	E	E	P	E		E	P	E	E	E		E			E	E		E	E			P				
108.00	**Trinidad Hydrologic Unit**																											
108.10	Big Lagoon Hydrologic Area	E	E	E	P	E	E	E		E	E	E		E	E		E	E	E	E	E		E	P	E			
108.20	Little River Hydrologic Area	P	E	E	P	E	E	E		P	E	E		E			E	E	E	E	E		E	P	E			
109.00	**Mad River Hydrologic Unit**																											
109.10	Blue Lake Hydrologic Area	E	E	E	E	E	E	E	P	E	E	E		E			E	E	P	E	E		E	E	E			
109.20	North Fork Mad River Hydrologic Area	E	E	E	E	E	E	E	P	E	E	E		E			E	E		E	E			P				
109.30	Butler Valley Hydrologic Area	E	E	E	E	E	E	E	P	E	E	E		E			E	E		E	E			P	E			
109.40	Ruth Hydrologic Area	E	E	E	E	E	E	E	E	E	E	E	E	E			E	E		E	E			P				
110.00	**Eureka Plain Hydrologic Unit**																											
	Jacoby Creek	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E		E*	P	E			
	Freshwater Creek	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E		E*	E	E			
	Elk River	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E		E*	P				
	Salmon Creek	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E		E*	P	E			
	Humboldt Bay	E	E	E	P		E	E	P	E	E	E		E			E	E	E	E	E	E	E*	E	E			

TABLE 2-1: BENEFICIAL USES OF WATERS OF THE NORTH COAST REGION

HU/HA/ HSA	HYDROLOGIC UNIT/AREA/ SUBUNIT/DRAINAGE FEATURE	BENEFICIAL USES																										
		MUN	AGR	IND	PRO	GWR	FRSH	NAV	POW	REC1	REC2	COMM	WARM	COLD	ASBS	SAL	WILD	RARE	MAR	MIGR	SPWN	SHELL	EST	AQUA	CUL	FLD	WET	WQE
111.00	**Eel River Hydrologic Unit**																											
111.10	Lower Eel River Hydrologic Area																											
111.11	Ferndale Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E		E			E	E	P	E	E	E	E	P	E			
111.12	Scotia Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E			P				
111.13	Larabee Creek Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E			P				
111.20	Van Duzen River Hydrologic Area																											
111.21	Hydesville Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E	E	E			E	E		E	E			P	E			
111.22	Bridgeville Hydrologic Subarea	E	E	E	P	E	E	E	E	E	E	E	E	E			E	E		E	E			P				
111.23	Yager Creek Hydrologic Subarea	E	E	E	P	E	E		P	E	E	E	E	E			E	E		E	E			E	E			
111.30	South Fork Eel River Hydrologic Area																											
111.31	Weott Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E	E	E			E	E		E	E			P				
111.32	Benbow Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E	E	E			E	E		E	E			P				
111.33	Laytonville Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E	E	E			E	E		E	E			P				
111.40	Middle Fork Eel River Hydrologic Area																											
111.41	Sequoia Hydrologic Subarea	E	E	E	P	E	E	E	E	E	E	E	E	E			E	E		E	E			P				
111.42	Spy Rock Hydrologic Subarea	E	E	E	P	E	E	E	E	E	E	E	E	E			E	E		E	E			P				
111.50	North Fork Eel River Hydrologic Area	E	E	E	P	E	E	E	E	E	E	E	E	E			E	E		E	E			P				
111.60	Upper Main Eel River Hydrologic Area																											
111.61	Outlet Creek Hydrologic Subarea	E	E	E	P	E		E	P	E	E	E	E	E			E	E		E	E			E				
111.62	Tomki Creek Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E	E	E			E	E		E	E			E				
111.63	Lake Pillsbury Hydrologic Subarea	E	E	E	P	E	E	E	E	E	E	E	E	E			E	E		E	E			E				

TABLE 2-1: BENEFICIAL USES OF WATERS OF THE NORTH COAST REGION

HU/HA/ HSA	HYDROLOGIC UNIT/AREA/ SUBUNIT/DRAINAGE FEATURE	MUN	AGR	IND	PRO	GWR	FRSH	NAV	POW	REC1	REC2	COMM	WARM	COLD	ASBS	SAL	WILD	RARE	MAR	MIGR	SPWN	SHELL	EST	AQUA	CUL	FLD	WET	WQE
111.70	Middle Fork Eel River Hydrologic Area																											
111.71	Eden Valley Hydrologic Subarea	E	E	E	P		E	E	P	E	E	E	E	E			E	E		E	E			E				
111.72	Round Valley Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E	P	E			E	E		E	E			E				
111.73	Black Butte River Hydrologic Subarea	E	E	E	P		E	E	E	E	E	E	E	E			E	E		E	E			P				
111.74	Wilderness Hydrologic Subarea	E	E	E	P		E	E	E	E	E	E	E	E			E	E		E	E			P				
112.00	**Cape Mendocino Hydrologic Unit**																											
112.10	Oil Creek Hydrologic Area	P	E	E	P		E		P	E	E	E		E			E	E		E	E		E	E	E			
112.20	Capetown Hydrologic Area	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E			P	E			
112.30	Mattole River Hydrologic Area	E	E	E	P	E	E	E	P	E	E	E	P	E			E	E		E	E		E	E				
113.00	**Mendocino Coast Hydrologic Unit**																											
113.10	Rockport Hydrologic Area	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E		E	P				
113.11	Usal Creek Hydrologic Subarea	E	P	P	P	E	E	E	P	E	E	E		E			E	E		E	E							
113.12	Wages Creek Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E							
113.13	Ten Mile River Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E		E	P				
113.20	Noyo River Hydrologic Area	E	E	E	P	E	E	E	E	E	E	E		E			E	E		E	E		E	E				
113.30	Big River Hydrologic Area	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E		E	P				
113.40	Albion River Hydrologic Area	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E		E	P				
113.50	Navarro River Hydrologic Area	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E		E	P				
113.60	Pt Arena Hydrologic Area																											
113.61	Greenwood Creek Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E		E	P				
113.62	Elk Creek Hydrologic Subarea	P	P	E	P	E	E	E	P	E	E	E		E			E	E		E	E		E	P				
113.63	Alder Creek Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E		E	P				
113.64	Brush Creek Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E		E	P				

TABLE 2-1: BENEFICIAL USES OF WATERS OF THE NORTH COAST REGION

HU/HA/ HSA	HYDROLOGIC UNIT/AREA/ SUBUNIT/DRAINAGE FEATURE	BENEFICIAL USES																										
		MUN	AGR	IND	PRO	GWR	FRSH	NAV	POW	REC1	REC2	COMM	WARM	COLD	ASBS	SAL	WILD	RARE	MAR	MIGR	SPWN	SHELL	EST	AQUA	CUL	FLD	WET	WQE
113.70	Garcia River Hydrologic Area	E	E	E	P		E	E	P	E	E	E		E			E	E		E	E		E	P				
113.80	Gualala River Hydrologic Area																											
113.81	North Fork Gualala Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E		E			E	E		E	E			E				
113.82	Rockpile Creek Hydrologic Subarea	E	E	E	P	E		E	P	E	E	E	E	E			E	E		E	E		E	P				
113.83	Buckeye Creek Hydrologic Subarea	E	E	E	P	E		E	P	E	E	E	E	E			E	E		E	E			P				
113.84	Wheatfield Fork Hydrologic Subarea	E	E	E	P	E		E	P	E	E	E	E	E			E	E		E	E			P				
113.85	Gualala Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E	E	E			E	E		E	E			P				
113.90	Russian Gulch Hydrologic Area	E	E	E	P	E				E	E	P		E		E	E			E	E			E				
114.00	**Russian River Hydrologic Unit**																											
114.10	Lower Russian River Hydrologic Area																											
114.11	Guerneville Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E	E	E			E	E		E	E	P	E	P				
114.12	Austin Creek Hydrologic Subarea	E	E	E	P	E		E	P	E	E	E	E	E			E	E		E	E			P				
114.20	Middle Russian River Hydrologic Area																											
114.21	Laguna Hydrologic Subarea	P	E	E	P	E	E	E	E	E	E	E	E	E			E	E		E	E	P		P				
114.22	Santa Rosa Hydrologic Subarea	E	E	E	P	E		E	P	E	E	E	E	E			E	E		E	E	P		P				
114.23	Mark West Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E	E	E			E	E		E	E	P		P				
114.24	Warm Springs Hydrologic Subarea	E	E	E	P	E	E	E	E	E	E	E	E	E			E	E		E	E			E				
114.25	Geyserville Hydrologic Subarea	E	E	E	P	E	E	E	P	E	E	E	E	E			E	E		E	E	P		P				
114.26	Sulphur Creek Hydrologic Subarea	E	E	E	P	E		E	P	E	E	E	E	E			E	E		E	E			P				

TABLE 2-1: BENEFICIAL USES OF WATERS OF THE NORTH COAST REGION

HU/HA/ HSA	HYDROLOGIC UNIT/AREA/ SUBUNIT/DRAINAGE FEATURE	BENEFICIAL USES																										
		MUN	AGR	IND	PRO	GWR	FRSH	NAV	POW	REC1	REC2	COMM	WARM	COLD	ASBS	SAL	WILD	RARE	MAR	MIGR	SPWN	SHELL	EST	AQUA	CUL	FLD	WET	WQE
114.30	Upper Russian River Hydrologic Area																											
114.31	Ukiah Hydrologic Subarea	E	E	E	P	E	E	E	E	E	E	E	E	E			E	E		E	E	P		P				
114.32	Coyote Valley Hydrologic Subarea	E	E	E	P	E	E	E	E	E	E	E	E	E			E	E		E	E			P				
114.33	Forsythe Creek Hydrologic Subarea	E	E	E	P	E		E	P	E	E	E	E	E			E	E		E	E			P				
115.00	**Bodega Hydrologic Unit**																											
115.10	Salmon Creek Hydrologic Area	E	E	E	P	E		E		E	E	E		E			E	E		E	E	P	E	P				
115.20	Bodega Harbor (or Bay) Hydrologic Area	E	E	E	P	E		E		E	E	E		E			E	E	E	E	E	E		E				
115.30	Estero Americano Hydrologic Area	E	E	E	P	E		E		E	E	E		E			E	E	E	E	E	P	E	P				
115.40	Estero de San Antonio Hydrologic Area	E	E	E	P	E		E		E	E	E		E			E	E	E	E	E	P	E	P				
	Minor Coastal Streams (not listed above**)	E	P	P	P	P	P	P		P	P	E	P	P			E	E	P	P	P		E	P	P			
	Ocean Waters			P	P			E		E	E	E			P		E	E	E	E	E	E		E				
	Bays			P	P			E		P	E	E	P	E			E	P	E	E	E	E	P	P	P			
	Saline Wetlands			P		P	P	P		P	P	P	P	P		P	P	P	P	P	P	P	P	P	P	P	E	P
	Freshwater Wetlands	P	P	P		P	P	P		P	P	P	P	P			P	P		P	P	P	P	P	P	P	E	P
	Estuaries	P	P	P	P		P	E	P	E	E	P	P	E			E	P	E	E	E	E	E	P	P			
	Groundwater	E	E	E	P																			P	E			

Waterbodies are grouped by hydrologic unit (HU) or hydrologic area (HA).
*EST use applies only to the estuarine portion of the waterbody as defined in Chapter 2. **Permanent and intermittent P = Potential E = Existing

APPENDIX C

CHAPTER 4. DISSOLVED OXYGEN SOURCE AND LINKAGE ANALYSIS

4.1 Introduction

This chapter identifies the processes that affect dissolved oxygen concentrations of the Shasta River and its tributaries and establishes a linkage between these processes and measured dissolved oxygen concentrations. First, the various processes that can affect dissolved oxygen concentrations in a surface waterbody are reviewed. Secondly, the chapter identifies the anthropogenic sources (or factors) that are affecting these processes and controlling dissolved oxygen concentrations in the Shasta River and its tributaries. The contributions from these sources are then quantified in Chapter 7.

4.1.1 Processes Affecting Dissolved Oxygen in Surface Waters

Dissolved oxygen levels in surface waters are controlled by a number of interacting processes (Figure 4.1), including:

- Photosynthesis;
- Respiration;
- Carbonaceous deoxygenation within the water column ;
- Nitrogenous deoxygenation ;
- Nitrification;
- Reaeration;
- Sediment oxygen demand; and
- Methanotrophy.

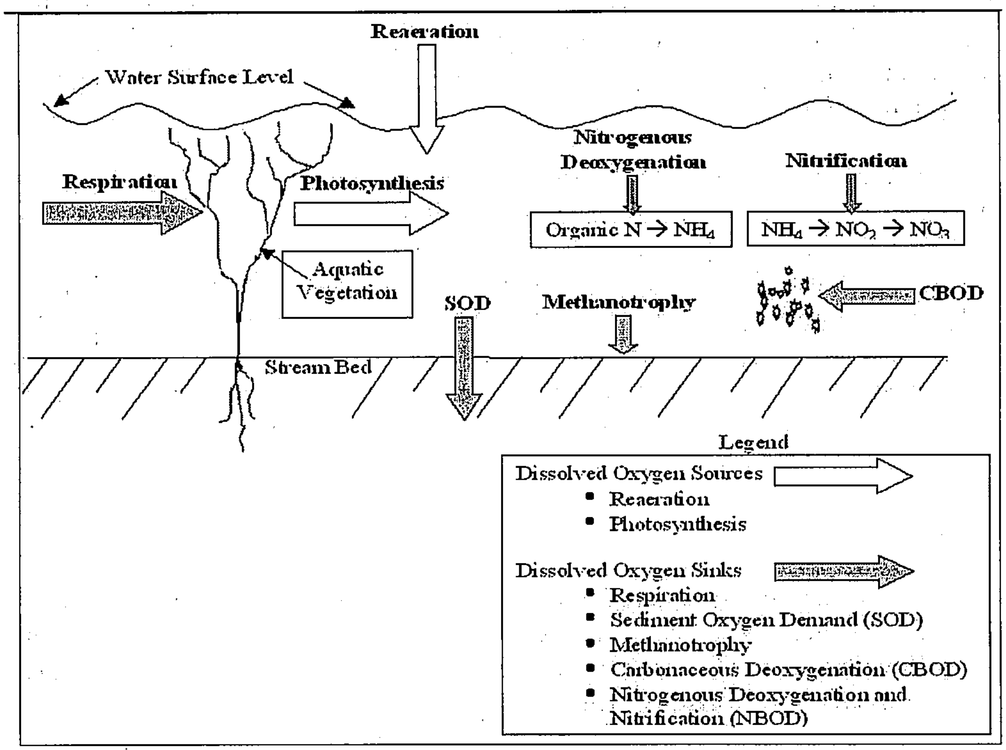


Figure 4.1: Physical, Chemical, and Biological Processes Affecting Dissolved Oxygen in Surface Water Bodies

- *Photosynthesis* is the process by which solar energy is stored as chemical energy in organic molecules. In this process, oxygen is liberated and carbon dioxide is sequestered.
- The organic matter produced by photosynthesis then serves as an energy source for nearly all other living organisms in the reverse processes of respiration and *decomposition* whereby oxygen is bonded with other elements.
- *Carbonaceous deoxygenation* is the technical term for decomposition, involving the consumption of oxygen by bacteria during the breakdown of organic material. Carbon dioxide is released as a byproduct of carbonaceous deoxygenation. When this oxidation is exerted on carbonaceous organic material that is suspended in the water column, it is measured as biochemical oxygen demand (BOD), typically measured as the amount of oxygen consumed during a five-day test period (BOD_5).
- *Nitrogenous deoxygenation* involves the conversion of organic nitrogen to ammonia (NH_4^+) by bacteria, a process that consumes oxygen.
- *Nitrification* is the process by which ammonia is oxidized to nitrite (NO^{2-}) and subsequently to nitrate (NO^{3-}); a process that also consumes oxygen.
- *Reaeration* is the process whereby atmospheric oxygen is transferred to a waterbody.
- *Sediment oxygen demand* refers to the consumption of oxygen by sediment and organisms (such as bacteria and invertebrates) through both the decomposition of organic matter and respiration by plants, bacteria, and invertebrates. Simplistically, sediment oxygen demand is carbonaceous deoxygenation and respiration occurring in the sediments.
- *Methanotrophy* is the process by which methane (CH_4) is biologically oxidized in aerobic environments, a process that consumes oxygen and forms carbon dioxide and water. Methanotrophy can occur in sediments and at the sediment-water interface. Where methanotrophy occurs, it can be measured as part of the overall sediment oxygen demand.

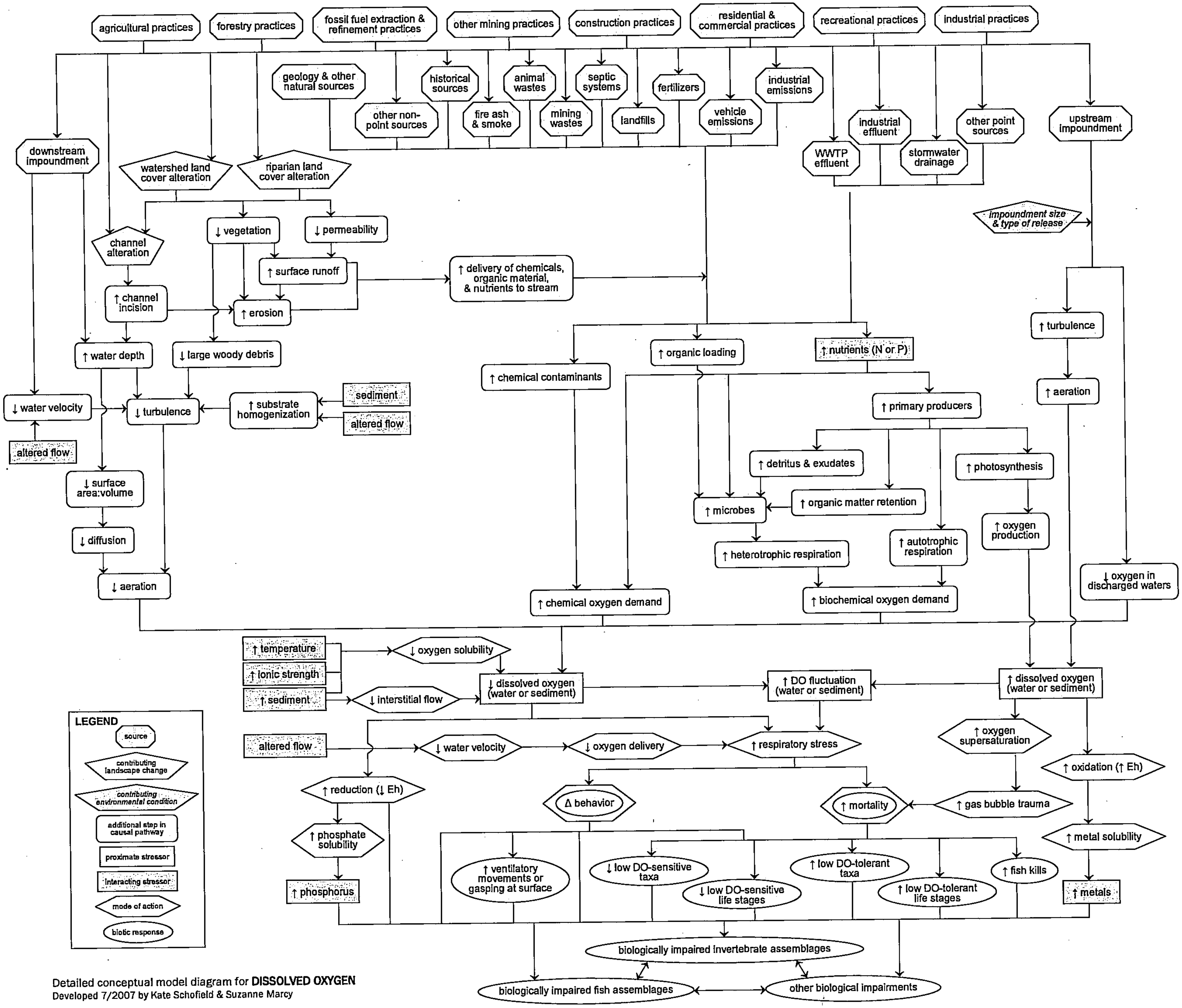
In addition to these processes, dissolved oxygen concentrations are affected by water temperature, salinity, and atmospheric pressure. Oxygen is soluble, or "dissolved" in water. The solubility of oxygen is a function of water temperature, salinity, and atmospheric pressure; decreasing with rising temperature and salinity, and increasing with rising atmospheric pressure. At sea level (1 atm of pressure) fresh water has a saturation dissolved oxygen concentration of about 14.6 mg/L at 0°C and 8.2 mg/L at 25°C. The connection between dissolved oxygen concentration and water temperature is important given the fact that the Shasta River is impaired by both high water temperatures and low dissolved oxygen concentrations.

4.2 Sources of Information

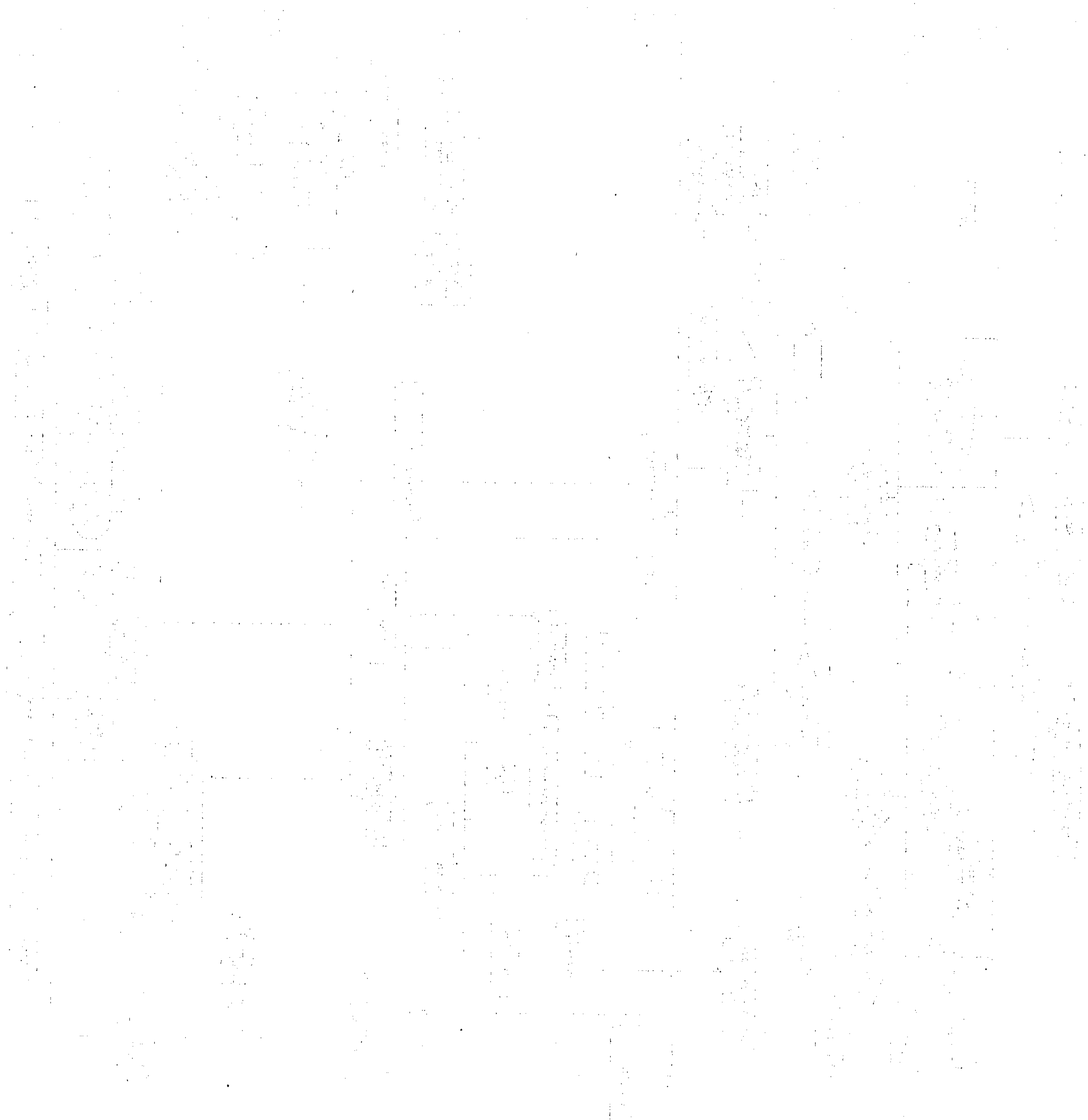
Much of the data and information used in the development of the dissolved oxygen TMDL was collected during the summers of 2002, 2003, and 2004 by Regional Water Board staff, with assistance from the U.S. Geological Survey and UC Davis Aquatic Ecosystems Analysis Laboratory. These data included:

- Hourly dissolved oxygen measurements at 16 sites;
- Hourly temperature measurements at 19 sites;

APPENDIX D



Detailed conceptual model diagram for **DISSOLVED OXYGEN**
Developed 7/2007 by Kate Schofield & Suzanne Marcy



APPENDIX E

The Effects of Dissolved Oxygen on Steelhead Trout, Coho Salmon, and Chinook Salmon Biology and Function by Life Stage

Katharine Carter
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California Regional Water Quality Control Board
North Coast Region

August 2005

Introduction
Adequate concentrations of dissolved oxygen in fresh water streams are critical for the survival of salmonids. Fish have evolved very efficient physiological mechanisms for obtaining and using oxygen in the water to oxygenate the blood and meet their metabolic demands (WDOE 2002). However, reduced levels of dissolved oxygen can impact growth and development of different life stages of salmon, including eggs, alevins, and fry, as well as the swimming, feeding and reproductive ability of juveniles and adults. Such impacts can affect fitness and survival by altering embryo incubation periods, decreasing the size of fry, increasing the likelihood of predation, and decreasing feeding activity. Under extreme conditions, low dissolved oxygen concentrations can be lethal to salmonids.

Literature reviewed for this analysis included EPA guidance, other states' standards, reports that compiled and summarized existing scientific information, and numerous laboratory studies. When possible, species-specific requirements were summarized for the following life stages: migrating adults, incubation and emergence, and freshwater rearing and growth. The following information applies to salmonids in general, with specific references to coho, Chinook, steelhead, and other species of salmonids as appropriate.

EFFECTS OF LOW DISSOLVED OXYGEN CONCENTRATIONS ON SALMONIDS

Adult Migration
Reduced concentrations of dissolved oxygen can negatively affect the swimming performance of migrating salmonids (Bjornn and Reiser 1991). The upstream migration by adult salmonids is typically a stressful endeavor. Sustained swimming over long distances requires high expenditures of energy and therefore requires adequate levels of dissolved oxygen. Migrating adult Chinook salmon in the San Joaquin River exhibited an avoidance response when dissolved oxygen was below 4.2 mg/L, and most Chinook waited to migrate until dissolved oxygen levels were at 5 mg/L or higher (Hallock et al. 1970).

Incubation/Emergence
Low levels of dissolved oxygen can be directly lethal to salmonids, and can also have sublethal effects such as changing the rate of embryological development, the time to hatching, and size of emerging fry (Spence et al. 1996). The embryonic and larval stages of salmonid development are especially susceptible to low dissolved oxygen levels as their ability to extract oxygen is not fully developed and their relative immobility inhibits their ability to migrate to more favorable conditions. The dissolved oxygen requirements for successful incubation of embryos and emergence of fry is tied to intragravel dissolved oxygen levels. Intragravel dissolved oxygen is typically a function of many chemical, physical, and hydrological variables, including: the dissolved oxygen concentration of the overlying stream water, water temperature, substrate size and porosity, biochemical oxygen demand of the intragravel water, sediment oxygen demand, the gradient and velocity of the stream, channel configuration, and depth of water. As a result the dissolved oxygen concentration within the gravels can be depleted causing problems for salmonid embryos and larvae, even when overlying surface water oxygen levels are suitable (USEPA 1986a).

Studies note that water column dissolved oxygen concentrations are typically estimated to be reduced by 1-3 mg/L as water is transmitted to redds containing developing eggs and larvae (WDOE 2002). USEPA (1986a) concluded that dissolved oxygen levels within the gravels should be considered to be at least 3 mg/L lower than concentrations in the overlying water. ODEQ (1995) expect the loss of an average of 3 mg/L dissolved oxygen from surface water to the gravels.

Incubation mortality

Phillips and Campbell (1961, as cited by Bjornn and Reiser 1991) concluded that intragravel dissolved oxygen must average 8 mg/L for embryos and alevins to survive well. After reviewing numerous studies Davis (1975) states that a dissolved oxygen concentration of 9.75 mg/L is fully protective of larvae and mature eggs, while at 8 mg/L the average member of the incubating population will exhibit symptoms of oxygen distress, and at 6.5 mg/L a large portion of the incubating eggs may be affected. Bjornn and Reiser (1991) reviewed numerous references and recommend that dissolved oxygen should drop no lower than 5 mg/L, and should be at or near saturation for successful incubation.

In a review of several laboratory studies, ODEQ (1995) concluded that at near optimum (10°C) constant temperatures acute mortality to salmonid embryos occurs at relatively low concentrations of dissolved oxygen, near or below 3 mg/L. Field studies reviewed by ODEQ (1995) demonstrate that embryo survival is low when the dissolved oxygen content in the gravels drops near or below 5 mg/L, and survival is greater at 8 mg/L.

Silver et al. (1963) performed a study with Chinook salmon and steelhead trout, rearing eggs at various constant dissolved oxygen concentrations and water velocities. They found that steelhead embryos held at 9.5°C and Chinook salmon embryos held at 11°C experienced complete mortality at dissolved oxygen concentrations of 1.6 mg/L. Survival of a large percentage of embryos reared at oxygen levels as low as 2.5 mg/L appeared to be possible by reduction of respiration rates and consequent reduction of growth and development rates.

In a field study Cobel (1961) found that the survival of steelhead embryos was correlated to intragravel dissolved oxygen in the redds, with higher survival at higher levels of dissolved oxygen. At 9.25 mg/L survival was 62%, but survival was only 16% at 2.6 mg/L. A laboratory study by Eddy (1971) found that Chinook salmon survival at 10.4 mg/L (13.5 °C) was approximately 67%, however at dissolved oxygen levels of 7.3 mg/L (13.5 °C) survival dropped to 49-57.6%. At temperatures more suitable for Chinook incubation (10.5 °C) Eddy (1971) found the percent survival remained high (over 90%) at dissolved oxygen levels from 11 mg/L to 3.5 mg/L; however, as dissolved oxygen levels decreased, the number of days to hatching increased and the mean dry weight of the fry decreased substantially. WDOE (2002) also points out that the studies above did not consider the act of emerging through the redds, and the metabolic requirements to emerge would be expected to be substantial. Therefore, it is likely that higher oxygen levels may be needed to fully protect hatching and emergence, than to just support hatching alone.

Incubation growth

Embryos can survive when dissolved oxygen is below saturation (and above a critical level), but development typically deviates from normal (Bjornn and Reiser 1991). Embryos were found to be smaller than normal, and hatching either delayed or premature, when dissolved oxygen was below saturation throughout development (Doudoroff and Warren 1965, as cited by Bjornn and Reiser 1991).

Garside (1966) found the number of days it took for rainbow trout to go from fertilization to hatching increased as dissolved oxygen concentrations and water temperature decreased. In this study, rainbow trout were incubated at temperatures between 2.5 - 17.5°C and dissolved oxygen levels from 2.5 - 11.3 mg/L. At 10°C and 7.5°C the total time for incubation was delayed 6 and 9 days respectively at dissolved oxygen levels of 2.5 mg/L versus embryos incubated at approximately 10.5 mg/L.

Silver et al. (1963) found that hatching of steelhead trout held at 9.5°C was delayed 5 to 8 days at dissolved oxygen concentrations averaging 2.6 mg/L versus embryos reared at 11.2 mg/L. A smaller delay of hatching was observed at oxygen levels of 4.2 and 5.7 mg/L, although none was apparent at 7.9 mg/L. For Chinook salmon held at 11°C, Silver et al. observed that embryos reared at oxygen levels lower than 11 mg/L experienced a delay in hatching, with the most significant delay in those reared at dissolved oxygen levels of 2.5 mg/L (6 to 9 days). The size of both Chinook and steelhead embryos increased with increases in dissolved oxygen up to 11.2 mg/L. External examination of embryos revealed abnormal structural development in Chinook salmon tested at dissolved oxygen concentrations of 1.6 mg/L, and abnormalities in steelhead trout at concentrations of 1.6 and 2.6 mg/L. The survival of Chinook salmon after hatching was only depressed at the 2.5 mg/L level, the lowest level at which hatching occurred, with lower mortalities occurring at higher velocities. Post hatching survival of steelhead trout could not be determined due to numerous confounding factors.

Shumway et al. (1964) conducted a laboratory study to determine the influence of oxygen concentration and water movement on the growth of steelhead trout and coho salmon embryos. The experiments were conducted at a temperature of 10°C and oxygen levels generally ranging from 2.5 - 11.5 mg/L and flows from 3 to 750 cm/hour. It was concluded that the median time to hatching decreased and size of fry increased as dissolved oxygen levels increased. For example, steelhead trout embryos reared at 2.9 mg/L hatched in approximately 41 days and had a wet weight of 17 mg, while embryos reared at 11.9 mg/L hatched in 36 days and weighed 32.3 mg. The authors found that a reduction of either the oxygen concentration or the water velocity will reduce the size of fry and increase the incubation period, although the affect of various water velocities tested was less than the effect of the different dissolved oxygen concentrations tested.

WDOE (2002) reviewed various references and found that at favorable incubation temperatures a mean oxygen concentration of 10.5 mg/L will result in a 2% reduction in growth. At other oxygen concentrations, growth is reduced as follows: 8% reduction at oxygen levels of 9 mg/L, 10% reduction at 7 mg/L, and a 25% reduction at 6 mg/L.

Incubation avoidance/preference
Alevin showed a strong preference for oxygen concentrations of 8 - 10 mg/L and moved through the gravel medium to these concentrations, avoiding concentrations from 4 - 6 mg/L (WDOE 2002).

Emergence mortality
"The hatching time, size, and growth rate of developing embryos is proportional to the dissolved oxygen concentrations up to 8 mg/L or greater. The ability of fry to survive their natural environment may be related to the size of fry at hatch (ODEQ 1995)." McMahon (1983) recommends dissolved oxygen levels be ≥ 8 mg/L for high survival and emergence of fry. In a review of controlled field and lab studies on emergence, WDOE (2002) states that average intragravel oxygen concentrations of 6 - 6.5 mg/L and lower can cause stress and mortality in developing embryos and alevin. It is also noted that field studies on emergence consistently cite intragravel oxygen concentrations of 8 mg/L or greater as being associated with or necessary for superior health and survival, oxygen concentrations below 6 - 7 mg/L result in a 50% reduction in survival through emergence, and oxygen concentrations below 5 mg/L result in negligible

survival. According to various laboratory studies, the threshold for complete mortality of emerging salmonids is noted to occur between 2 - 2.5 mg/L (WDOE 2002).

After reviewing numerous literature sources, the USEPA (1986a) concluded that the embryonic and larval stages of salmonid development will experience no impairment when water column dissolved oxygen concentrations are 11 mg/L. This translates into an intragravel dissolved oxygen concentration of 8 mg/L (USEPA assumes a 3 mg/L loss between the surface water and gravels). Table 1 from the USEPA (1986a) lists the water column and intragravel dissolved oxygen concentrations associated with various health effects. These health affects range from no production impairment to acute mortality.

Table 1: Dissolved oxygen concentrations and their effects salmonid embryo and larval stages (USEPA, 1986a).

Level of Effect	Water Column DO (mg/L)	Intragravel DO (mg/L)
No Production Impairment	11	8*
Slight Production Impairment	9	6*
Moderate Production Impairment	8	5*
Severe Production Impairment	7	4*
Limit to Avoid Acute Mortality	6	3*

* A 3 mg/L loss is assumed between the water column dissolved oxygen levels and those intragravel.

Freshwater Rearing and Growth

Swimming and activity

Salmonids are strong active swimmers requiring highly oxygenated waters (Spence 1996), and this is true during the rearing period when the fish are feeding, growing, and avoiding predation. Salmonids may be able to survive when dissolved oxygen concentrations are low (<5 mg/L), but growth, food conversion efficiency, and swimming performance will be adversely affected (Bjornn and Reiser 1991). Davis (1975) reviewed numerous studies and reported no impairment to rearing salmonids if dissolved oxygen concentrations averaged 9 mg/L, while at oxygen levels of 6.5 mg/L "the average member of the community will exhibit symptoms of oxygen distress", and at 4 mg/L a large portion of salmonids may be affected. Dahlberg et al. (1968) state that at temperatures near 20°C any considerable decrease in the oxygen concentration below 9 mg/L (the air saturation level) resulted in some reduction of the final swimming speed. They found that between dissolved oxygen concentrations of 7 to 2 mg/L the swimming speed of coho declined markedly with the decrease in dissolved oxygen concentration.

In a laboratory study, Davis et al. (1963) reported that the maximum sustainable swimming speeds of wild juvenile coho salmon were reduced when dissolved oxygen dropped below saturation at water temperatures of 10, 15, and 20°C. Air-saturation values for these dissolved oxygen concentrations were cited as 11.3, 10.2, and 9.2 mg/L respectively. They found that the maximum sustained swimming speeds (based on first and second swimming failures at all temperatures) were reduced by 3.2 - 6.4%, 5.9 - 10.1%, 9.9 - 13.9%, 16.7 - 21.2%, and 26.6 - 33.8% at dissolved oxygen concentrations of 7, 6, 5, 4, and 3 mg/L respectively. The authors also conducted tests on juvenile Chinook salmon and found that the percent reductions from maximum swimming speed at temperatures ranging from 11 to 15°C were greater than those for juvenile coho. At the dissolved oxygen concentrations listed above swimming speeds were decreased by 10%, 14%, 20%, 27%, and 38% respectively.

WDOE (2002) reviewed various data and concluded that swimming fitness of salmonids is maximized when the daily minimum dissolved oxygen levels are above 8 - 9 mg/L. Jones et al. (1971, as cited by USEPA 1986a) found the swimming speed of rainbow trout was decreased 30% from maximum at dissolved oxygen concentrations of 5.1 mg/L and 14°C. At oxygen levels of 3.8 mg/L and a temperature of 22°C, they found a 43% reduction in the maximum swimming speed.

Growth

In a review of constant oxygen exposure studies WDOE (2002) concluded salmonid growth rates decreased less than 10% at dissolved oxygen concentrations of 8 mg/L or more, less than 20% at 7 mg/L, and generally less than 22% at 5 - 6 mg/L. Herrmann (1958) found that the mean percentage of weight gain in juvenile coho held at constant dissolved oxygen concentrations was 7.2% around 2 mg/L, 33.6% at 3 mg/L, 55.8% near 4 mg/L, and 67.9% at or near 5 mg/L. In a laboratory study Fischer (1963) found that the growth rates of juvenile coho exposed to constant oxygen concentrations ranging from 2.5 to 35.5 mg/L (fed to satiation, temperature at approximately 18 °C) dramatically decreased with decreases in the oxygen concentration below 9.5 mg/L (air saturation level). WDOE (2002) concludes that a monthly or weekly average concentration of 9 mg/L, and a monthly average of the daily minimum concentrations should be at or above 8 - 8.5 mg/L to have a negligible effect (5% or less) on growth and support healthy growth rates.

Food conversion efficiency is related to dissolved oxygen levels and the process becomes less efficient when oxygen concentrations are below 4 - 4.5 mg/L (ODEQ 1995). Bjornn and Reiser (1991) state that growth, food conversion efficiency, and swimming performance are adversely affected when dissolved oxygen concentrations are <5 mg/L. The USEPA (1986a) reviewed growth data from a study conducted by Warren et al. (1973) where tests were conducted at various temperatures to determine the growth of coho and Chinook. USEPA cites that, with the exception of tests conducted at 22 °C, the results supported the idea that the effects of low dissolved oxygen become more severe at higher temperatures.

Brett and Blackburn (1981) performed a laboratory study to determine the growth rate and food conversion efficiency of young coho and sockeye salmon fed full rations. Tests were performed at dissolved oxygen concentrations ranging from 2 to 15 mg/L at a constant temperature of 15°C, the approximate optimum temperature for growth of Pacific Salmon. Both species showed a strong dependence of growth on the environmental oxygen concentrations when levels were below 5 mg/L. For coho, zero growth was observed at dissolved oxygen concentrations of 2.3 mg/L. The mean value for maximum coho growth occurred at 4 mg/L, and at dissolved oxygen concentrations above this level growth did not appear to be dependant on the dissolved oxygen. Sockeye displayed zero growth at oxygen levels of 2.6 mg/L, and reached the zone of independence (growth not dependant on dissolved oxygen levels) at 4.2 mg/L. Brett and Blackburn (1981) conclude that the critical inflection from oxygen dependence to independence occurs at 4 - 4.2 mg/L for coho and sockeye.

Herrmann et al. (1962) studied the influence of various oxygen concentrations on the growth of age 0 coho salmon held at 20 °C. Coho were held in containers at a constant mean dissolved oxygen level ranging from 2.1 - 9.9 mg/L and were fed full rations. The authors concluded that oxygen concentrations below 5 mg/L resulted in a sharp decrease in growth and food consumption. A reduction in the mean oxygen levels from 8.3 mg/L to 6 and 5 mg/L resulted in slight decreases in food consumption and growth. Weight gain in grams per gram of food consumed was slightly depressed at dissolved oxygen concentrations near 4 mg/L, and were markedly reduced at lower concentrations. At oxygen levels of 2.1 and 2.3 mg/L, many fish died and the surviving fish lost weight and consumed very little food.

USEPA (1986a) calculated the median percent reduction in growth rate of Chinook and coho salmon fed full rations at various dissolved oxygen concentrations. They calculated no reduction in growth at dissolved oxygen concentrations of 8 and 9 mg/L, and a 1% reduction in growth at 7 mg/L for both species. At 6 mg/L Chinook and coho growth were reduced by 7% and 4% respectively. Dissolved oxygen levels of 4 mg/L result in a 29% reduction in growth for Chinook salmon and 21% reduction in growth for coho. At 3 mg/L there was a 47% decrease in Chinook growth and a 37% reduction in coho growth. USEPA (1986a) states that due to the variability inherent in growth studies the reductions in growth rates seen above 6 mg/L are not usually statistically significant, while reductions in growth at dissolved oxygen levels below 4 mg/L are considered severe.

Avoidance and preference
Salmonids have been reported to actively avoid areas with low dissolved oxygen concentrations, which is likely a useful protective mechanism that enhances survival (Davis 1975). Field and laboratory studies have found that avoidance reactions in juvenile salmonids consistently occur at concentrations of 5 mg/L and lower, and there is some indication that avoidance is triggered at concentrations as high as 6 mg/L. Therefore these dissolved oxygen levels should be considered a potential barrier to the movement and habitat selection of salmonids (WDOE 2002).

Spoor (1990) performed a laboratory study on the distribution of fingerling brook trout in dissolved oxygen concentration gradients. Sixteen gradients between 1 and 8.9 mg/L were used for the study to determine what level of dissolved oxygen is preferred by the brook trout. It was found that in the absence of a gradient with dissolved oxygen concentrations at 6 mg/L or more throughout the system, the fish moved freely without showing preference or avoidance. Movement from low to higher oxygen concentrations were noted throughout the study. Fish moved away from water with dissolved oxygen concentrations from 1 - 1.9 mg/L within one hour, moved away from water with dissolved oxygen concentrations of 2 - 2.9 mg/L within 1 - 2 hours, and moved away more slowly from concentrations of 3 - 3.9 mg/L. From his study, Spoor (1990) concluded that brook trout will avoid oxygen concentrations below 4 mg/L, and preferred oxygen levels of 5 mg/L or higher.

Whitmore et al. (1960) performed studies with juvenile coho and Chinook salmon to determine their avoidance reaction to dissolved oxygen concentration of 1.5, 3 , 4.5, and 6 mg/L at variable river water temperatures. Juvenile Chinook salmon showed marked avoidance of oxygen concentrations near 1.5, 3, and 4.5 mg/L in the summer at mean temperatures ranging from 20.7 - 22.8°C, but no avoidance to levels near 6 mg/L at a mean temperature of 18.4°C. Chinook did not show as strong an avoidance to these oxygen levels in the fall when water temperatures were lower, ranging from 11.8 - 13.2°C. Chinook showed little avoidance of dissolved oxygen concentrations near 4.5 mg/L during the fall, and no avoidance to concentrations near 6 mg/L. In all cases avoidance became progressively larger with reductions in the oxygen concentration below 6 mg/L. Seasonal differences of avoidance are most likely due to differences in water temperature. At temperatures ranging from 18.4 - 19°C juvenile coho salmon showed some avoidance to all of the above oxygen concentrations, including 6 mg/L. Their behavior was more erratic than that of Chinook, and their avoidance of concentrations near 4.5 mg/L and lower was not as pronounced at corresponding temperatures. The juvenile coho often started upon entering water with low dissolved oxygen and then darted around until they found their way out of the experimental channel.

USEPA (1986a) performed a literature review and cites the effects of various dissolved oxygen concentrations on salmonid life stages other than embryonic and larval (Table 2). These effects range from no impairment at 8 mg/L to acute mortality at dissolved oxygen levels below 3 mg/L.

Table 2: Dissolved oxygen concentrations and their effects on salmonid life stages other than embryonic and larval (USEPA 1986a).

Level of Effect	Water Column DO (mg/L)
No Production Impairment	8
Slight Production Impairment	6
Moderate Production Impairment	5
Severe Production Impairment	4
Limit to Avoid Acute Mortality	3

Lethality

Salmonid mortality begins to occur when dissolved oxygen concentrations are below 3 mg/L for periods longer than 3.5 days (USEPA 1986a). A summary of various field study results by WDOE (2002) reports that significant mortality occurs in natural waters when dissolved oxygen concentrations fluctuate the range of 2.5 - 3 mg/L. Long-term (20 - 30 days) constant exposure to mean dissolved oxygen concentrations below 3 - 3.3 mg/L is likely to result in 50% mortality of juvenile salmonids (WDOE 2002). According to a short-term (1 - 4 hours) exposure study by Burdick et al. (1954, as cited by WDOE, 2002), in warm water (20 - 21°C) salmonids may require daily minimum oxygen levels to remain above 2.6 mg/L to avoid significant (50%) mortality. From these and other types of studies, WDOE (2002) concluded that juvenile salmonid mortality can be avoided if daily minimum dissolved oxygen concentration remain above 3.9 mg/L, and the monthly or weekly average of minimum concentrations remains above 4.6 mg/L.

EFFECTS OF HIGH TOTAL DISSOLVED GAS CONCENTRATIONS ON SALMONIDS

High levels of total dissolved gas (TDG), including dissolved oxygen, can be harmful to salmonids and other fish and result in "gas bubble disease". This occurs when dissolved gases in their circulatory system come out of solution and form bubbles which block the flow of blood through the capillary vessels (USEPA 1986b). There are several ways TDG supersaturation can occur, including excessive algal photosynthesis which can create supersaturated dissolved oxygen conditions (USEPA 1986b). Thus, to protect salmonids and other freshwater fish the USEPA has set criteria for TDG stating that levels should not exceed 110% of the saturation value.

Numerous studies have been conducted to determine the mortality rate of salmonids exposed to various levels of TDG. Mesa et al. (2000) conducted laboratory experiments on juvenile Chinook and steelhead, exposing them to different levels of TDG and found no fish died when held at 110% TDG for up to 22 days. When fish were exposed to 120% TDG, 20% of juvenile Chinook died within 40 to 120 hours while 20% of juvenile steelhead died within 20 to 35 hours. At TDG levels of 130% Chinook mortality reached 20% after 3 to 6 hours and steelhead mortality was 20% after 5 to 7 hours. Gale et al. (2001) held adult female spring Chinook at mean TDG levels ranging from 114.1% to 125.5% and found the time to first mortality ranged from 10 to 68 hours.

USEPA (1986b) discusses various studies on the effects of TDG on salmonids. The following studies are all cited from the USEPA 1986 water quality criteria document. Bouck et al. (1975) found TDG levels of 115% and above to be acutely lethal to most species of salmonids, and levels of 120% TDG are rapidly lethal to all salmonids. Conclusions drawn from Ebel et al. (1975) and Rulfison and Abel (1971) include the following:

- Adult and juvenile salmonids confined to shallow water (1 m) with TDG levels above 115% experience substantial levels of mortality.
- Juvenile salmonids exposed sublethal levels TDG supersaturation are able to recover when returned to normally saturated water, while adults do not recover and generally die.

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APPENDIX F

United States
Environmental Protection
Agency

Office of Water
Regulations and Standards
Criteria and Standards Division
Washington, DC 20460

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Water

EPA

Ambient Water Quality Criteria for Dissolved Oxygen

Ambient Aquatic Life Water Quality Criteria for Dissolved Oxygen

(Freshwater)

U.S. Environmental Protection Agency
Office of Research and Development
Environmental Research Laboratories
Duluth, Minnesota
Narragansett, Rhode Island

NOTICES

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Ambient Water Quality Criteria for Dissolved Oxygen

FRESHWATER AQUATIC LIFE

I. Introduction

A sizable body of literature on the oxygen requirements of freshwater aquatic life has been thoroughly summarized (Doudoroff and Shumway, 1967, 1970; Warren et al., 1973; Davis, 1975a,b; and Alabaster and Lloyd, 1980). These reviews and other documents describing the dissolved oxygen requirements of aquatic organisms (U.S. Environmental Protection Agency, 1976; International Joint Commission, 1976; Minnesota Pollution Control Agency, 1980) and more recent data were considered in the preparation of this document. The references cited below are limited to those considered to be the most definitive and most representative of the preponderance of scientific evidence concerning the dissolved oxygen requirements of freshwater organisms. The guidelines used in deriving aquatic life criteria for toxicants (Federal Register, 45 FR 79318, November 28, 1980) are not applicable because of the different nature of the data bases. Chemical toxicity data bases rely on standard 96-h LC50 tests and standard chronic tests; there are very few data of either type on dissolved oxygen.

Over the last 10 years the dissolved oxygen criteria proposed by various agencies and researchers have generally reflected two basic schools of thought. One maintained that a dynamic approach should be used so that the criteria would vary with natural ambient dissolved oxygen minima in the waters of concern (Doudoroff and Shumway, 1970) or with dissolved oxygen requirements of fish expressed in terms of percent saturation (Davis, 1975a,b). The other maintained that, while not ideal, a single minimum allowable concentration should adequately protect the diversity of aquatic life in fresh waters (U.S. Environmental Protection Agency, 1976). Both approaches relied on a simple minimum allowable dissolved oxygen concentration as the basis for their criteria. A simple minimum dissolved oxygen concentration was also the most practicable approach in waste load allocation models of the time.

Expressing the criteria in terms of the actual amount of dissolved oxygen available to aquatic organisms in milligrams per liter (mg/l) is considered more direct and easier to administer compared to expressing the criteria in terms of percent saturation. Dissolved oxygen criteria expressed as percent saturation, such as discussed by Davis (1975a,b), are more complex and could often result in unnecessarily stringent criteria in the cold months and potentially unprotective criteria during periods of high ambient temperature or at high elevations. Oxygen partial pressure is subject to the same temperature problems as percent saturation.

The approach recommended by Doudoroff and Shumway (1970), in which the criteria vary seasonally with the natural minimum dissolved oxygen concentrations in the waters of concern, was adopted by the National Academy of Sciences and National Academy of Engineering (NAS/NAE, 1973). This approach has some merit, but the lack of data (natural minimum concentrations) makes its application difficult, and it can also produce unnecessarily stringent or unprotective criteria during periods of extreme temperature.

The more simplistic approach to dissolved oxygen criteria has been supported by the findings of a select committee of scientists specifically established by the Research Advisory Board of the International Joint Commission to review the dissolved oxygen criterion for the Great Lakes (Magnuson et al., 1979). The committee concluded that a simple criterion (an average criterion of 6.5 mg/l and a minimum criterion of 5.5 mg/l) was preferable to one based on percent saturation (or oxygen partial pressure) and was scientifically sound because the rate of oxygen transfer across fish gills is directly dependent on the mean difference in oxygen partial pressure across the gill. Also, the total amount of oxygen delivered to the gills is a more specific limiting factor than is oxygen partial pressure _per se_. The format of this otherwise simple criterion was more sophisticated than earlier criteria with the introduction of a two-concentration criterion comprised of both a mean and a minimum. This two-concentration criteria structure is similar to that currently used for toxicants (Federal Register, 45 FR 79318, November 28, 1980). EPA agrees with the International Joint Commission's conclusions and will recommend a two-number criterion for dissolved oxygen.

The national criteria presented herein represent the best estimates, based on the data available, of dissolved oxygen concentrations necessary to protect aquatic life and its uses. Previous water quality criteria have either emphasized (Federal Water Pollution Control Administration, 1968) or rejected (National Academy of Sciences and National Academy of Engineering, 1972) separate dissolved oxygen criteria for coldwater and warmwater biota. A warmwater-coldwater dichotomy is made in this criterion. To simplify discussion, however, the text of the document is split into salmonid and nonsalmonid sections. The salmonid-nonsalmonid dichotomy is predicated on the much greater knowledge regarding the dissolved oxygen requirements of salmonids and on the critical influence of intergravel dissolved oxygen concentration on salmonid embryonic and larval development. Nonsalmonid fish include many other coldwater and coolwater fish plus all warmwater fish. Some of these species are known to be less sensitive than salmonids to low dissolved oxygen concentrations. Some other nonsalmonids may prove to be at least as sensitive to low dissolved oxygen concentrations as the salmonids; among the nonsalmonids of likely sensitivity are the herrings (Clupeidae), the smelts (Osmeridae), the pikes (Esocidae), and the sculpins (Cottidae). Although there is little published data regarding the dissolved oxygen requirements of most nonsalmonid species, there is apparently enough anecdotal information to suggest that many coolwater species are more sensitive to dissolved oxygen depletion than are warmwater species. According to the American Fisheries Society (1978), the term "coolwater fishes" is not vigorously defined, but it refers generally to those species which are distributed by temperature preference between the "coldwater" salmonid communities to the north and the more diverse, often centrarchid-dominated "warmwater" assemblages to the south. Many states have more stringent dissolved oxygen standards for colder waters, waters that contain either salmonids, nonsalmonid coolwater fish, or the sensitive centrarchid, the smallmouth bass.

The research and sociological emphasis for dissolved oxygen has been biased towards fish, especially the more economically important species in the family Salmonidae. Several authors (Doudoroff and Shumway, 1970; Davis, 1975a,b) have discussed this bias in considerable detail and have drawn similar conclusions regarding the effects of low dissolved oxygen on freshwater invertebrates. Doudoroff and Shumway (1970) stated that although some invertebrate species are about as sensitive as the moderately susceptible fishes, all invertebrate species need not be protected in order to protect the food source for fisheries because many invertebrate species, inherently more tolerant than fish, would increase in abundance. Davis (1975a,b) also concluded that invertebrate species would probably be adequately protected if the fish populations are protected. He stated that the composition of invertebrate communities may shift to more tolerant forms selected from the resident community or recruited from outside the community. In general, stream invertebrates that are requisite riffle-dwellers probably have a higher dissolved oxygen requirement than other aquatic invertebrates. The riffle habitat maximizes the potential dissolved oxygen flux to organisms living in the high water velocity by rapidly replacing the water in the immediate vicinity of the organisms. This may be especially important for organisms that exist clinging to submerged substrate in the riffles. In the absence of data to the contrary, EPA will follow the assumption that a dissolved oxygen criterion protective of fish will be adequate.

One of the most difficult problems faced during this attempt to gather, interpret, assimilate, and generalize the scientific data base for dissolved oxygen effects on fish has been the variability in test conditions used by investigators. Some toxicological methods for measuring the effects of chemicals on aquatic life have been standardized for nearly 40 years; this has not been true of dissolved oxygen research. Acute lethality tests with dissolved oxygen vary in the extreme with respect to types of exposure (constant vs. declining), duration of exposure (a few hours vs. a week or more), type of endpoint (death vs. loss of equilibrium), type of oxygen control (nitrogen stripping vs. vacuum degassing), and type of exposure chamber (open to the atmosphere vs. sealed). In addition there are the normal sources of variability that influence standardized toxicity tests, including seasonal differences in the condition of test fish, acclimation or lack of acclimation to test conditions, type and level of feeding, test temperature, age of test fish, and stresses due to test conditions. Chronic toxicity tests are typically of two types, full life cycle tests or early life stage tests. These have come to be rather rigorously standardized and are essential to the toxic chemical criteria established by EPA. These tests routinely are assumed to include the most sensitive life stage, and the criteria then presume to protect all life stages. With dissolved oxygen research, very few tests would be considered legitimate chronic tests; either they fail to include a full life cycle, they fail to include both embryo and larval stages, or they fail to include an adequate period of post-larval feeding and growth.

Instead of establishing year-round criteria to protect all life stages, it may be possible to establish seasonal criteria based on the life stages present. Thus, special early life stage criteria are routinely accepted for salmonid early life stages because of their usual intergravel environment. The same concept may be extended to any species that appear to have more stringent dissolved oxygen requirements during one period of their life history. The flexibility afforded by such a dichotomy in criteria carries with it the responsibility to accurately determine the presence or absence of the more sensitive stages prior to invocation of the less stringent criteria. Such presence/absence data must be more site-specific than national in scope, so that temperature, habitat, or calendar specifications are not possible in this document. In the absence of such site-specific determinations the default criteria would be those that would protect all life stages year-round; this is consistent with the present format for toxic chemical criteria.

II. Salmonids

The effects of various dissolved oxygen concentrations on the well-being of aquatic organisms have been studied more extensively for fish of the family Salmonidae (which includes the genera *Coregonus*, *Oncorhynchus*, *Prosopium*, *Salmo*, *Salvelinus*, *Stenodus*, and *Thymallus*) than for any other family of organisms. Nearly all these studies have been conducted under laboratory conditions, simplifying cause and effect analysis, but minimizing or eliminating potentially important environmental factors, such as physical and chemical stresses associated with suboptimal water quality, as well as competition, behavior, and other related activities. Most laboratory studies on the effects of dissolved oxygen concentrations on salmonids have emphasized growth, physiology, or embryonic development. Other studies have described acute lethality or the effects of dissolved oxygen concentration on swimming performance.

A. Physiology

Many studies have reported a wide variety of physiological responses to low dissolved oxygen concentrations. Usually, these investigations were of short duration, measuring cardiovascular and metabolic alterations resulting from hypoxic exposures of relatively rapid onset. While these data provide only minimal guidance for establishing environmentally acceptable dissolved oxygen concentrations, they do provide considerable insight into the mechanisms responsible for the overall effects observed in the entire organism. For example, a good correlation exists between oxygen dissociation curves for rainbow trout blood (Cameron, 1971) and curves depicting the reduction in growth of salmonids (Brett and Blackburn, 1981; Warren et al., 1973) and the reduction in swimming ability of salmonids (Davis et al., 1963). These correlations indicate that the blood's reduced oxygen loading capacity at lower dissolved oxygen concentrations limits the amount of oxygen delivered to the tissues, restricting the ability of fish to maximize metabolic performance.

In general, the significance of metabolic and physiological studies on the establishment of dissolved oxygen criteria must be indirect, because their applicability to environmentally acceptable dissolved oxygen concentrations requires greater extrapolation and more assumptions than those required for data on growth, swimming, and survival.

B. Acute Lethal Concentrations

Doudoroff and Shumway (1970) summarized studies on lethal concentrations of dissolved oxygen for salmonids; analysis of these data indicates that the test procedures were highly variable, differing in duration, exposure regime, and reported endpoints. Only in a few cases could a 96-hr LC50 be calculated. Mortality or loss of equilibrium usually occurred at concentrations between 1 and 3 mg/l.

Mortality of brook trout has occurred in less than one hour at 10°C at dissolved oxygen concentrations below 1.2 mg/l, and no fish survived exposure at or below 1.5 mg/l for 10 hours (Shepard, 1955). Lethal dissolved oxygen concentrations increase at higher water temperatures and longer exposures. A 3.5 hr exposure killed all trout at 1.1 and 1.6 mg/l at 10 and 20°C, respectively (Downing and Merkens, 1957). A 3.5-day exposure killed all trout at 1.3 and 2.4 mg/l at 10 and 20°C, respectively. The corresponding no-mortality levels were 1.9 and 2.7 mg/l. The difference between dissolved oxygen concentrations causing total mortality and those allowing complete survival was about 0.5 mg/l when exposure duration was less than one week. If the period of exposure to low dissolved oxygen concentrations is limited to less than 3.5 days, concentrations of dissolved oxygen of 3 mg/l or higher should produce no direct mortality of salmonids.

More recent studies confirm these lethal levels in chronic tests with early life stages of salmonids (Siefert et al., 1974; Siefert and Spoor, 1973; Brooke and Colby, 1980); although studies with lake trout (Carlson and Siefert, 1974) indicate that 4.5 mg/l is lethal at 10°C (perhaps a marginally acceptable temperature for embryonic lake trout).

C. Growth

Growth of salmonids is most susceptible to the effects of low dissolved oxygen concentrations when the metabolic demands or opportunities are greatest. This is demonstrated by the greater sensitivity of growth to low dissolved oxygen concentrations when temperatures are high and food most plentiful (Warren et al., 1973). A total of more than 30 growth tests have been reported by Herrmann et al. (1962), Fisher (1963), Warren et al. (1973), Brett and Blackburn (1981), and Spoor (1981). Results of these tests are not easily compared because the tests encompass a wide range of species, temperatures, food types, and fish sizes. These factors produced a variety of control growth rates which, when combined with a wide range of test durations and fish numbers, resulted in an array of statistically diverse test results.

The results from most of these 30-plus tests were converted to growth rate data for fish exposed to low dissolved oxygen concentrations and were compared to control growth rates by curve-fitting procedures (JRB Associates, 1984). Estimates of growth rate reductions were similar regardless of the type of curve employed, but the quadratic model was judged to be superior and was used in the growth rate analyses contained in this document. The apparent relative sensitivity of each species to dissolved oxygen depletion may be influenced by fish size, test duration, temperature, and diet. Growth rate data (Table 1) from these tests with salmon and trout fed unrestricted rations indicated median growth rate reductions of 7, 14, and 25 percent for fish held at 6, 5, and 4 mg/l, respectively (JRB Associates, 1984). However, median growth rate reductions for the various species ranged from 4 to 9 percent at 6 mg/l, 11 to 17 percent at 5 mg/l, and 21 to 29 percent at 4 mg/l.

Table 1. Percent reduction in growth rate of salmonids at various dissolved oxygen concentrations expressed as the median value from n tests with each species (calculated from JRB Associates, 1984).

Dissolved Oxygen (mg/l)	Species (number of tests)					
	Chinook Salmon (6)	Coho Salmon (12)	Sockeye Salmon (1)	Rainbow Trout (2)	Brown Trout (1)	Lake Trout (2)
9	0	0	0	0	0	0
8	0	0	0	1	0	0
7	1	1	2	5	1	2
6	7	4	6	9	6	7
5	16	11	12	17	13	16
4	29	21	22	25	23	29
3	47	37	33	37	36	47
Median Temp. (°C)	15	18	15	12	12	12

Considering the variability inherent in growth studies, the apparent reductions in growth rate sometimes seen above 6 mg/l are not usually statistically significant. The reductions in growth rate occurring at dissolved oxygen concentrations below about 4 mg/l should be considered severe; between 4 mg/l and the threshold of effect, which variably appears to be between 6 and 10 mg/l in individual tests, the effect on growth rate is moderate to slight if the exposures are sufficiently long.

Within the growth data presented by Warren et al. (1973), the greatest effects and highest thresholds of effect occurred at high temperatures (17.8 to 21.7°C). In two tests conducted at about 8.5°C, the growth rate reduction at 4 mg/l of dissolved oxygen averaged 12 percent. Thus, even at the maximum feeding levels in these tests, dissolved oxygen levels down to 5 mg/l probably have little effect on growth rate at temperatures below 10°C.

Growth data from Warren et al. (1973) included chinook salmon tests conducted at various temperatures. These data (Table 2) indicated that growth tests conducted at 10-15°C would underestimate the effects of low dissolved oxygen concentrations at higher temperatures by a significant margin. For example, at 5 mg/l growth was not affected at 13°C but was reduced by 34 percent if temperatures were as high as 20°C. Examination of the test temperatures associated with the growth rate reductions listed in Table 1 shows that most data represent temperatures between 12 and 15°C. At the higher temperatures often associated with low dissolved oxygen concentrations, the growth rate reductions would have been greater if the generalizations of the chinook salmon data are applicable to salmonids in general. Coho salmon growth studies (Warren et al., 1973) showed a similar result over a range of temperatures from 9 to 18°C, but the trend was reversed in two tests near 22°C (Table 3). Except for the 22°C coho tests, the coho and chinook salmon results support the idea that effects of low dissolved oxygen become more severe at higher temperatures. This conclusion is supported by data on largemouth bass (to be discussed later) and by the increase in metabolic rate produced by high temperatures.

Table 2. Influence of temperature on growth rate of chinook salmon held at various dissolved oxygen concentrations (calculated from Warren et al., 1973; JRB Associates, 1984).

Dissolved Oxygen (mg/l)	Percent Reduction in Growth Rate at					
	8.4°C	13.0°C	13.2°C	17.8°C	18.6°C	21.7°C
9	0	0	0	0	0	0
8	0	0	0	0	2	0
7	0	0	4	0	8	2
6	0	0	8	5	19	14
5	0	0	16	16	34	34
4	7	4	25	33	53	65
3	26	22	36	57	77	100

Table 3. Influence of temperature on growth rate of coho salmon held at various dissolved oxygen concentrations (calculated from Warren et al., 1973; JRB Associates, 1984).

Dissolved Oxygen (mg/l)	Percent Reduction in Growth Rate at					
	8.6°C	12.9°C	13.0°C	18.0°C	21.6°C	21.8°C
10	0	0	0	0	0	0
9	0	0	0	5	0	0
8	0	1	2	10	0	0
7	1	4	6	17	0	6
6	4	10	13	27	0	1
5	9	18	23	38	0	7
4	17	29	36	51	4	19
3	28	42	51	67	6	37

Effects of dissolved oxygen concentration on the growth rate of salmonids fed restricted rations have been less intensively investigated. Thatcher (1974) conducted a series of tests with coho salmon at 15°C over a wide range of food consumption rates at 3, 5, and 8 mg/l of dissolved oxygen. The only significant reduction in growth rate was observed at 3 mg/l and food consumption rates greater than about 70 percent of maximum. In these studies, Thatcher noted that fish at 5 mg/l appeared to expend less energy in swimming activity than those at 8 mg/l. In natural conditions, where fish may be rewarded for energy expended defending preferred territory or searching for food, a dissolved oxygen concentration of 5 mg/l may restrict these activities.

The effect of forced activity and dissolved oxygen concentration on the growth of coho salmon was studied by Hutchins (1974). The growth rates of salmon fed to repletion at a dissolved oxygen concentration of 3 mg/l and held at current velocities of 8.5 and 20 cm/sec were reduced by 20 and 65 percent, respectively. At 5 mg/l, no reduction of growth rate was seen at the slower velocity, but a 15 percent decrease occurred at the higher velocity.

The effects of various dissolved oxygen concentrations on the growth rate of coho salmon (~ 5 cm long) in laboratory streams with an average current velocity of 12 cm/sec have been reported by Warren et al. (1973). In this series of nine tests, salmon consumed aquatic invertebrates living in the streams. Results at temperatures from 9.5° to 15.5°C supported the results of earlier laboratory studies; at higher growth rates (40 to 50 mg/g/day), dissolved oxygen levels below 5 mg/l reduced growth rate, but at lower growth rates (0 to 20 mg/g/day), no effects were seen at concentrations down to 3 mg/l.

The applicability of these growth data from laboratory tests depends on the available food and required activity in natural situations. Obviously, these factors will be highly variable depending on duration of exposure, growth rate, species, habitat, season, and size of fish. However, unless effects of these variables are examined for the site in question, the laboratory results should be used. The attainment of critical size is vital to the smolting of anadromous salmonids and may be important for all salmonids if size-related transition to feeding on larger or more diverse food organisms is an advantage. In the absence of more definitive site-specific, species-specific growth data, the data summary in Tables 1, 2, and 3 represent the best estimates of the effects of dissolved oxygen concentration on the potential growth of salmonid fish.

D. Reproduction

No studies were found that described the effects of low dissolved oxygen on the reproduction, fertility, or fecundity of salmonid fish.

E. Early Life Stages

Determining the dissolved oxygen requirements for salmonids, many of which have embryonic and larval stages that develop while buried in the gravel of streams and lakes, is complicated by complex relationships between the dissolved oxygen supplies in the gravel and the overlying water. The dissolved oxygen supply of embryos and larvae can be depleted even when the dissolved oxygen concentration in the overlying body of water is otherwise acceptable. Intergravel dissolved oxygen is dependent upon the balance between the combined respiration of gravel-dwelling organisms, from bacteria to fish embryos, and the rate of dissolved oxygen supply, which is dependent upon rates of water percolation and convection, and dissolved oxygen diffusion.

Water flow past salmonid eggs influences the dissolved oxygen supply to the microenvironment surrounding each egg. Regardless of dissolved oxygen concentration in the gravel, flow rates below 100 cm/hr directly influence the oxygen supply in the microenvironment and hence the size at hatch of salmonid fish. At dissolved oxygen levels below 6 mg/l the time from fertilization to hatch is longer as water flow decreases (Silver et al., 1963; Shumway et al., 1964).

The dissolved oxygen requirements for growth of salmonid embryos and larvae have not been shown to differ appreciably from those of older salmonids. Under conditions of adequate water flow (≥100 cm/hr), the weight attained by salmon and trout larvae prior to feeding (swimup) is decreased less than 10 percent by continuous exposure to concentrations down to 3 mg/l (Brannon, 1965; Chapman and Shumway, 1978). The considerable developmental delay which occurs at low dissolved oxygen conditions could have survival and growth implications if the time of emergence from gravel, or first feeding, is critically related to the presence of specific food organisms, stream flow, or other factors (Carlson and Siefert, 1974; Siefert and Spoor, 1974). Effects of low dissolved oxygen on early life stages are probably most significant during later embryonic development when critical dissolved oxygen concentrations are highest (Alderdice et al., 1958) and during the first few months post-hatch when growth rates are usually highest. The latter authors studied the effects of 7-day exposure of embryos to low dissolved oxygen at various stages during incubation at otherwise high dissolved oxygen concentrations. They found no effect of 7-day exposure at concentrations above 2 mg/l (at a water flow of 85 cm/hr).

Embryos of mountain whitefish suffered severe mortality at a mean dissolved oxygen concentration of 3.3 mg/l (2.8 mg/l minimum) and some reduction in survival was noted at 4.6 mg/l (3.8 mg/l minimum); at 4.6 mg/l, hatching was delayed by 1 to 2 weeks (Sieffert et al., 1974). Delayed hatching resulted in poorer growth at the end of the test, even at dissolved oxygen concentrations of 6 mg/l.

Evaluating intergravel dissolved oxygen concentrations is difficult because of the great spatial and temporal variability produced by differences in stream flow, bottom topography, and gravel composition. Even within the same redd, dissolved oxygen concentrations can vary by 5 or 6 mg/l at a given time (Koski, 1965). Over several months, Koski repeatedly measured the dissolved oxygen concentrations in over 30 coho salmon redds and the overlying stream water in three small, forested (unlogged) watersheds. The results of these measurements indicated that the average intraredd dissolved oxygen concentration was about 2 mg/l below that of the overlying water. The minimum concentrations measured in the redds averaged about 3 mg/l below those of the overlying water and probably occurred during the latter period of intergravel development when water temperatures were warmer, larvae larger, and overlying dissolved oxygen concentrations lower.

Coble (1961) buried steelhead trout eggs in streambed gravel, monitored nearby intergravel dissolved oxygen and water velocity, and noted embryo survival. There was a positive correlation between dissolved oxygen concentration, water velocity, and embryo survival. Survival ranged from 16 to 26 percent whenever mean intergravel dissolved oxygen concentrations were below 6 mg/l or velocities were below 20 cm/hr; at dissolved oxygen concentrations above 6 mg/l and velocities over 20 cm/hr, survival ranged from 36 to 62 percent. Mean reductions in dissolved oxygen concentration between stream and intergravel waters averaged about 5 mg/l as compared to the 2 mg/l average reduction observed by Koski (1965) in the same stream. One explanation for the different results is that the intergravel water flow may have been higher in the natural redds studied by Koski (not determined) than in the artificial redds of Coble's investigation. Also, the density of eggs near the sampling point may have been greater in Coble's simulated redds.

A study of dissolved oxygen concentrations in brook trout redds was conducted in Pennsylvania (Hollander, 1981). Brook trout generally prefer areas of groundwater upwelling for spawning sites (Witzel and MacCrimmon, 1983). Dissolved oxygen and temperature data offer no indication of groundwater flow in Hollender's study areas, however, so that differences between water column and intergravel dissolved oxygen concentrations probably represent intergravel dissolved oxygen depletion. Mean dissolved oxygen concentrations in redds averaged 2.1, 2.8, and 3.7 mg/liter less than the surface water in the three portions of the study. Considerable variation of intergravel dissolved oxygen concentration was observed between redds and within a single redd. Variation from one year to another suggested that dissolved oxygen concentrations will show greater intergravel depletion during years of low water flow.

Until more data are available, the dissolved oxygen concentration in the intergravel environment should be considered to be at least 3 mg/l lower than the oxygen concentration in the overlying water. The 3 mg/l differential is assumed in the criteria, since it reasonably represents the only two available studies based on observations in natural redds (Koski, 1965; Hollender, 1981). When siltation loads are high, such as in logged or agricultural watersheds, lower water velocity within the gravel could additionally reduce dissolved oxygen concentrations around the eggs. If either greater or lesser differentials are known or expected, the criteria should be altered accordingly.

F. Behavior

Ability of chinook and coho salmon to detect and avoid abrupt differences in dissolved oxygen concentrations was demonstrated by Whitmore et al. (1960). In laboratory troughs, both species showed strong preference for oxygen levels of 9 mg/l or higher over those near 1.5 mg/l; moderate selection against 3.0 mg/l was common and selection against 4.5 and 6.0 mg/l was sometimes detected.

The response of young Atlantic salmon and brown trout to low dissolved oxygen depended on their age; larvae were apparently unable to detect and avoid water of low dissolved oxygen concentration, but fry 6-16 weeks of age showed a marked avoidance of concentrations up to 4 mg/l (Bishai, 1962). Older fry (26 weeks of age) showed avoidance of concentrations up to 3 mg/l.

In a recent study of the rainbow trout sport fishery of Lake Taneycomo, Missouri, Weithman and Haas (1984) have reported that reductions in minimum daily dissolved oxygen concentrations below 6 mg/l are related to a decrease in the harvest rate of rainbow trout from the lake. Their data suggest that lowering the daily minimum from 6 mg/l to 5, 4, and 3 mg/l reduces the harvest rate by 20, 40, and 60 percent, respectively. The authors hypothesized that the reduced catch was a result of reduction in feeding activity. This mechanism of action is consistent with Thatcher's (1974) observation of lower activity of coho salmon at 5 mg/l in laboratory growth studies and the finding of Warren et al. (1973) that growth impairment produced by low dissolved oxygen appears to be primarily a function of lower food intake.

A three-year study of a fishery on planted rainbow trout was published by Heimer (1984). This study found that the catch of planted trout increased during periods of low dissolved oxygen in American Falls reservoir on the Snake River in Idaho. The author concluded that the fish avoided areas of low dissolved oxygen and high temperature and the increased catch rate was a result of the fish concentrating in areas of more suitable oxygen supply and temperature.

G. Swimming

Effects of dissolved oxygen concentrations on swimming have been demonstrated by Davis et al. (1963). In their studies, the maximum sustained swimming speeds (in the range of 30 to 45 cm/sec) of juvenile coho salmon were reduced by 8.4, 12.7, and 19.9 percent at dissolved oxygen concentrations of 6, 5, and 4 mg/l, respectively. Over a temperature range from 10 to 20°C, effects were slightly more severe at cooler temperatures. Jones (1971) reported 30 and 43 percent reductions of maximal swimming speed of rainbow trout at dissolved oxygen concentrations of 5.1 (14°C) and 3.8 (22°C) mg/l, respectively. At lower swimming speeds (2 to 4 cm/sec), coho and chinook salmon at 20°C were generally able to swim for 24 hours at dissolved oxygen concentrations of 3 mg/l and above (Katz et al., 1958). Thus, the significance of lower dissolved oxygen concentrations on swimming depends on the level of swimming performance required for the survival, growth, and reproduction of salmonids. Failure to escape from predation or to negotiate a swift portion of a spawning migration route may be considered an indirect lethal effect and, in this regard, reductions of maximum swimming performance can be very important. With these exceptions, moderate levels of swimming activity required by salmonids are apparently little affected by concentrations of dissolved oxygen that are otherwise acceptable for growth and reproduction.

H. Field Studies

Field studies of salmonid populations are almost non-existent with respect to effects of dissolved oxygen concentrations. Some of the systems studied by Ellis (1937) contained trout, but of those river systems in which trout or other salmonids were most likely (Columbia River and Upper Missouri River) no stations were reported with dissolved oxygen concentrations below 5 mg/l, and 90 percent of the values exceeded 7 mg/l.

III. Non-Salmonids

The amount of data describing effects of low dissolved oxygen on non-salmonid fish is more limited than that for salmonids, yet must cover a group of fish with much greater taxonomic and physiological variability. Salmonid criteria must provide for the protection and propagation of 38 species in 7 closely related genera; the non-salmonid criteria must provide for the protection and propagation of some 600 freshwater species in over 40 diverse taxonomic families. Consequently, the need for subjective technical judgment is greater for the non-salmonids.

Many of the recent, most pertinent data have been obtained for several species of Centrarchidae (sunfish), northern pike, channel catfish, and the fathead minnow. These data demonstrate that the larval stage is generally the most sensitive life stage. Lethal effects on larvae have been observed at dissolved oxygen concentrations that may only slightly affect growth of juveniles of the same species.

A. Physiology

Several studies of the relationship between low dissolved oxygen concentrations and resting oxygen consumption rate constitute the bulk of the physiological data relating to the effect of hypoxia on nonsalmonid fish. A reduction in the resting metabolic rate of fish is generally believed to represent a marked decrease in the scope for growth and activity, a net decrease in the supply of oxygen to the tissues, and perhaps a partial shift to anaerobic energy sources. The dissolved oxygen concentration at which reduction in resting metabolic rate first appears is termed the critical oxygen concentration.

Studies with brown bullhead (Grigg, 1969), largemouth bass (Cech et al., 1979), and goldfish and carp (Beamish, 1964), produced estimates of critical dissolved oxygen concentrations for these species. For largemouth bass, the critical dissolved oxygen concentrations were 2.8 mg/l at 30°C, < 2.6 mg/l at 25°C, and < 2.3 mg/l at 20°C. For brown bullheads the critical concentration was about 4 mg/l. Carp displayed critical oxygen concentrations near 3.4 and 2.9 mg/l at 10 and 20°C, respectively, and goldfish critical concentrations of dissolved oxygen were about 1.8 and 3.5 mg/l at 10 and 20°C, respectively. A general summary of these data suggest critical dissolved oxygen concentrations between 2 and 4 mg/l, with higher temperatures usually causing higher critical concentrations.

Critical evaluation of the data of Beamish (1964) suggest that the first sign of hypoxic stress is not the decrease in oxygen consumption, but rather an increase, perhaps as a result of metabolic cost of passing an increased ventilation volume over the gills. These increases were seen in carp at 5.8 mg/l at 20°C and at 4.2 mg/l at 10°C.

B. Acute Lethal Concentrations

Based on the sparse data base describing acute effects of low dissolved oxygen concentrations on nonsalmonids, many non-salmonids appear to be considerably less sensitive than salmonids. Except for larval forms, no non-salmonids appear to be more sensitive than salmonids. Spoor (1977) observed lethality of largemouth bass larvae at a dissolved oxygen concentration of 2.5 mg/l after only a 3-hr exposure. Generally, adults and juveniles of all species studied survive for at least a few hours at concentrations of dissolved oxygen as low as 3 mg/l. In most cases, no mortality results from acute exposures to 3 mg/l for the 24- to 96-h duration of the acute tests. Some non-salmonid fish appear to be able to survive a several-day exposure to concentrations below 1 mg/l (Moss and Scott, 1961; Downing and Merkens, 1957), but so little is known about the latent effects of such exposure that short-term survival cannot now be used as an indication of acceptable dissolved oxygen concentrations. In addition to the unknown latent effects of exposure to very low dissolved oxygen concentrations, there are no data on the effects of repeated short-term exposures. Most importantly, data on the tolerance to low dissolved oxygen concentrations are available for only a few of the numerous species of non-salmonid fish.

C. Growth

Stewart et al. (1967) conducted several growth studies with juvenile largemouth bass and observed reduced growth at 5.9 mg/l and lower concentrations. Five of six experiments included dissolved oxygen concentrations between 5 and 6 mg/l; dissolved oxygen concentrations of 5.1 and 5.4 mg/l produced reductions in growth rate of 20 and 14 percent, respectively, but concentrations of 5.8 and 5.9 mg/l had essentially no effect on growth. The efficiency of food conversion was not reduced until dissolved oxygen concentrations were much lower, indicating that decreased food consumption was the primary cause of reduced growth.

When channel catfish fingerlings held at 8, 5, and 3 mg/l were fed as much as they could eat in three daily feedings, there were significant reductions in feeding and weight gain (22 percent) after a 6 week exposure to 5 mg/l (Andrews et al., 1973). At a lower feeding rate, growth after 14 weeks was reduced only at 3 mg/l. Fish exposed to 3 mg/l swam lethargically, fed poorly and had reduced response to loud noises. Raible (1975) exposed channel catfish to several dissolved oxygen concentrations for up to 177 days and observed a graded reduction in growth at each concentration below 6 mg/l. However, the growth pattern for 6.8 mg/l was comparable to that at 5.4 mg/l. He concluded that each mg/l increase in dissolved oxygen concentrations between 3 and 6 mg/l increased growth by 10 to 13 percent.

Carlson et al. (1980) studied the effect of dissolved oxygen concentration on the growth of juvenile channel catfish and yellow perch. Over periods of about 10 weeks, weight gain of channel catfish was lower than that of control fish by 14, 39, and 54 percent at dissolved oxygen concentrations of 5.0, 3.4, and 2.1 mg/l, respectively. These differences were produced by decreases in growth rate of 5, 18, and 23 percent (JRB Associates, 1984), pointing out the importance of differentiating between effects on weight gain and effects on growth rate. When of sufficient duration, small reductions in growth rate can have large effects on relative weight gain. Conversely, large effects on growth rate may have little effect on annual weight gain if they occur only over a small proportion of the annual growth period. Yellow perch appeared to be more tolerant to low dissolved oxygen concentrations, with reductions in weight gain of 2, 4, and 30 percent at dissolved oxygen concentrations of 4.9, 3.5, and 2.1 mg/l, respectively.

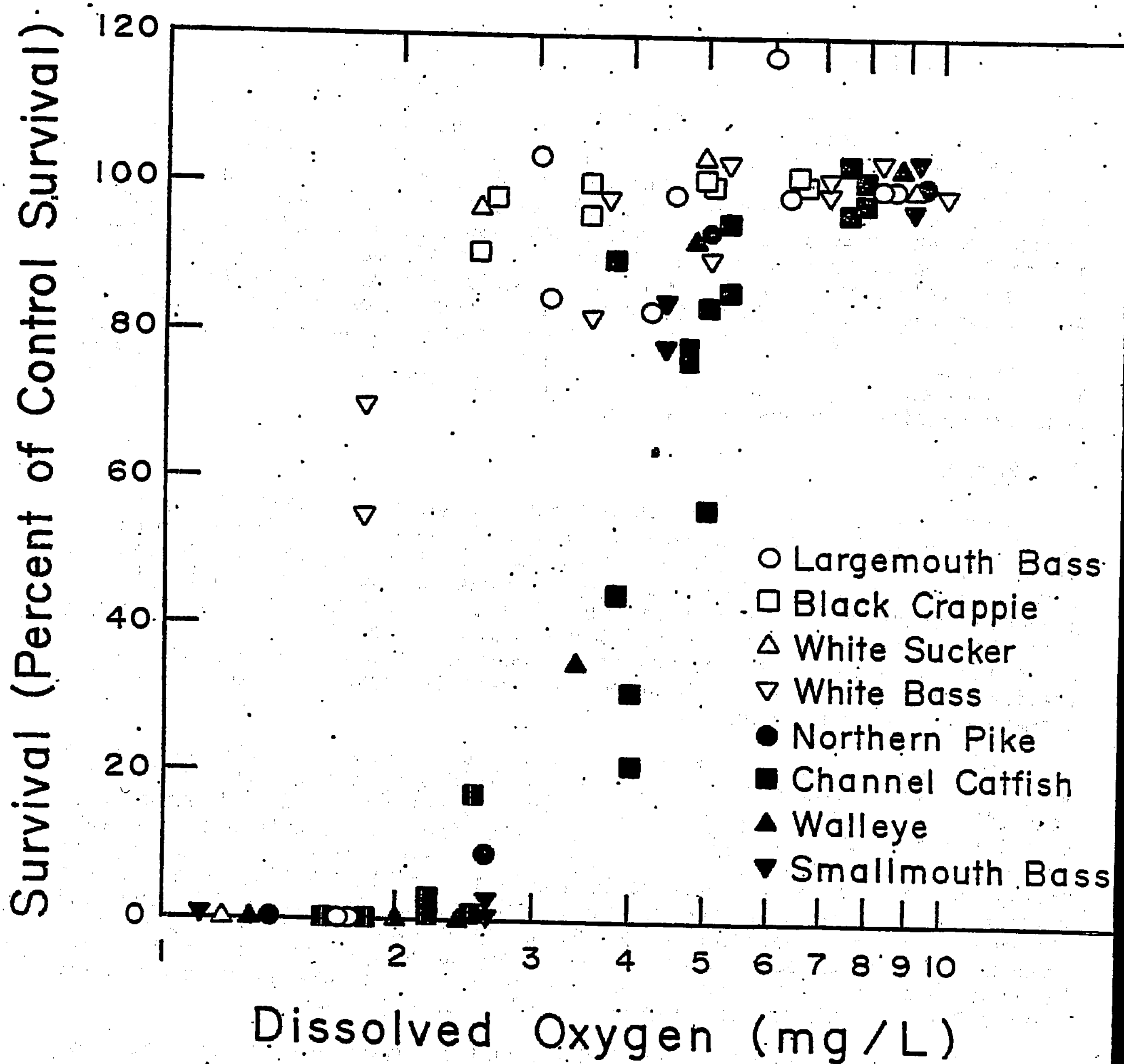

Figure 1. Effect of continuous exposure to various mean dissolved oxygen concentrations on survival of embryonic and larval stages of eight species of nonsalmonid fish. Minima recorded in these tests averaged about 0.3 mg/l below the mean concentrations.

The data of Stewart et al. (1967), Carlson et al. (1980), and Adelman and Smith (1972) were analyzed to determine the relationship between growth rate and dissolved oxygen concentration (JRB Associates, 1984). Yellow perch appeared to be very resistant to influences of low dissolved oxygen concentrations, northern pike may be about as sensitive as salmonids, while largemouth bass and channel catfish are intermediate in their response (Table 4). The growth rate relations modeled from Adelman and Smith are based on only four data points, with none in the critical dissolved oxygen region from 3 to 5 mg/l. Nevertheless, these growth data for northern pike are the best available for nonsalmonid coldwater fish. Adelman and Smith observed about a 65 percent reduction in growth of juvenile northern pike after 6-7 weeks at dissolved oxygen concentrations of 1.7 and 2.6 mg/l. At the next higher concentration (5.4 mg/l), growth was reduced 5 percent.

Table 4. Percent reduction in growth rate of some nonsalmonid fish held at various dissolved oxygen concentrations expressed as the median value from n tests with each species (calculated from JRB Associates, 1984).

Dissolved Oxygen (mg/l)	Species (number of tests)			
	Northern Pike (1)	Largemouth Bass (6)	Channel Catfish (1)	Yellow Perch (1)
9	0	0	0	0
8	1	0	0	0
7	4	0	1	0
6	9	0	3	0
5	16	1	7	0
4	25	9	13	0
3	35	17	20	7
2	--	51	29	22
Median Temp (°C)	19	26	25	20

Brake (1972) conducted a series of studies on juvenile largemouth bass in two artificial ponds to determine the effect of reduced dissolved oxygen concentration on consumption of mosquitofish and growth during 10 2-week exposures. The dissolved oxygen in the control pond was maintained near air-saturation (8.3 to 10.4 mg/l) and the other pond contained mean dissolved oxygen concentrations from 4.0 to 6.0 mg/l depending upon the individual test. The temperature, held near the same level in both ponds for each test, ranged from 13 to 27°C. Food consumption and growth rates of the juvenile bass, maintained on moderate densities of forage fish, increased with temperature and decreased at the reduced dissolved oxygen concentrations except at 13°C. Exposure to that temperature probably slowed metabolic processes of the bass so much that their total metabolic rates were not limited by dissolved oxygen except at very low concentrations. These largemouth bass studies clearly support the idea that higher temperatures exacerbate the adverse effects of low dissolved oxygen on the growth rate of fish (Table 5). Comparisons of Brake's pond studies with the laboratory growth studies of Stewart et al. (1967) suggest that laboratory growth studies may significantly underestimate the adverse effect of low dissolved oxygen on fish growth. Stewart's six studies with largemouth bass are summarized in Table 4 and Brake's data are presented in Table 5. All of Stewart's tests were conducted at 26°C, about the highest temperature in Brake's studies, but comparison of the data show convincingly that at dissolved oxygen concentrations between 4 and 6 mg/l the growth rate of bass in ponds was reduced 17 to 34 percent rather than the 1 to 9 percent seen in the laboratory studies. These results suggest that the ease of food capture in laboratory studies may result in underestimating effects of low dissolved oxygen on growth rates in nature.

Table 5. Effect of temperature on the percent reduction in growth rate of largemouth bass exposed to various dissolved oxygen concentrations in ponds (after Brake, 1972; JRB Associates, 1984).

Temperature (°C)	Percent Reduction in Growth Rate at		
	4.2 ± 0.2 mg/l	4.9 ± 0.2 mg/l	5.8 ± 0.2 mg/l
13.3	0	--	--
13.6	--	--	7
16.3	--	18	--
16.7	--	--	15
18.1	--	19	--
18.6	--	34	--
18.7	18	--	--
23.3	26	--	--
26.7	--	--	17
27.4	31	--	--

Brett and Blackburn (1981) reanalyzed the growth data previously published by other authors for largemouth bass, carp, and coho salmon in addition to their own results for young coho and sockeye salmon. They concluded for all species that above a critical level ranging from 4.0 to 4.5 mg/l, decreases in growth rate and food conversion efficiency were not statistically significant in these tests of relatively short duration (6 to 8 weeks) under the pristine conditions of laboratory testing. EPA believes that a more accurate estimate of the dissolved oxygen concentrations that have no effect on growth and a better estimate of concentration:effect relationships can be obtained by curve-fitting procedures (JCB Associates, 1984) and by examining these results from a large number of studies. Brett and Blackburn added an additional qualifying statement that it was not the purpose of their study to seek evidence on the acceptable level of dissolved oxygen in nature because of the problems of environmental complexity involving all life stages and functions, the necessary levels of activity to survive in a competitive world, and the interaction of water quality (or lack of it) with varying dissolved oxygen concentrations. Their cautious concern regarding the extrapolation to the real world of results obtained under laboratory conditions is consistent with that of numerous investigators.

D. Reproduction

A life-cycle exposure of the fathead minnow beginning with 1- to 2-month old juveniles was conducted and effects of continuous low dissolved oxygen concentrations on various life stages indicated that the most sensitive stage was the larval stage (Brungs, 1971). No spawning occurred at 1 mg/l, and the number of eggs produced per female was reduced at 2 mg/l but not at higher concentrations. Where spawning occurred, the percentage hatch of embryos (81-89 percent) was not affected when the embryos were exposed to the same concentrations as their parents. Hatching time varied with temperature, which was not controlled, but with decreasing dissolved oxygen concentration the average incubation time increased gradually from the normal 5 to nearly 8 days. Mean larval survival was 6 percent at 3 mg/l and 25 percent at 4 mg/l. Mean survival of larvae at 5 mg/l was 66 percent as compared to 50 percent at control dissolved oxygen concentrations. However, mean growth of surviving larvae at 5 mg/l was about 20 percent lower than control larval growth. Siefert and Herman (1977) exposed mature black crappies to constant dissolved oxygen concentrations from 2.5 mg/l to saturation and temperatures of 13-20°C. Number of spawnings, embryo viability, hatching success, and survival through swim-up were similar at all exposures.

E. Early Life Stages

Larval and juvenile non-salmonids are frequently more sensitive to exposures to low dissolved oxygen than are other life stages. Peterka and Kent (1976) conducted semi-controlled experiments at natural spawning sites of northern pike, bluegill, pumpkinseed, and smallmouth bass in Minnesota. Dissolved oxygen concentrations were measured 1 and 10 cm from the bottom, with observations being made on hatching success and survival of embryos, sac larvae, and, in some instances, larvae. Controlled exposure for up to 8 hours was performed _in situ_ in small chambers with the dissolved oxygen controlled by nitrogen stripping. For all species tested, tolerance to short-term exposure to low concentrations decreased from embryonic to larval stages. Eight-hour exposure of embryos and larvae of northern pike to dissolved oxygen concentrations caused no mortality of embryos at 0.6 mg/l but was 100 percent lethal to sac-larvae and larvae. The most sensitive stage, the larval stage, suffered complete mortality following 8 hours at 1.6 mg/l; the next higher concentration, 4 mg/l, produced no mortality. Smallmouth bass were at least as sensitive, with nearly complete mortality of sac-larvae resulting from 6-hour exposure to 2.2 mg/l, but no mortality occurred after exposure to 4.2 mg/l. Early life stages of bluegill were more hardy, with embryos tolerating 4-hour exposure to 0.5 mg/l, a concentration lethal to sac-larvae; sac-larvae survived similar exposure to 1.8 mg/l, however. Because the most sensitive stage of northern pike was the later larval stage, and because the younger sac-larval stages of smallmouth bass and bluegill were the oldest stages tested, the tests with these latter species may not have included the most sensitive stage. Based on these tests, 4 mg/l is tolerated, at least briefly, by northern pike and may be tolerated by smallmouth bass, but concentrations as high as 2.2 mg/l are lethal.

Several studies have provided evidence of mortality or other significant damage to young non-salmonids as a result of a few weeks exposure to dissolved oxygen concentrations in the 3 to 6 mg/l range. Siefert et al. (1973) exposed larval northern pike to various dissolved oxygen concentrations at 15 and 19°C and observed reduced survival at concentrations as high as 2.9 and 3.4 mg/l. Most of the mortality at these concentrations occurred at the time the larvae initiated feeding. Apparently the added stress of activity at that time or a greater oxygen requirement for that life stage was the determining factor. There was a marked decrease in growth at concentrations below 3 mg/l. In a similar study lasting 20 days, survival of walleye embryos and larvae was reduced at 3.4 mg/l (Siefert and Spoor, 1974), and none survived at lower concentrations. A 20 percent reduction in the survival of smallmouth bass embryos and larvae occurred at a concentration of 4.4 mg/l (Siefert et al., 1974) and at 2.5 mg/l all larvae died in the first 5 days after hatching. At 4.4 mg/l hatching occurred earlier than in the controls and growth among survivors was reduced. Carlson and Siefert (1974) concluded that concentrations from 1.7 to 6.3 mg/l reduced the growth of early stages of the largemouth bass by 10 to 20 percent. At concentrations as high as 4.5 mg/l, hatching was premature and feeding was delayed; both factors could indirectly influence survival, especially if other stresses were to occur simultaneously. Carlson et al. (1974) also observed that embryos and larvae of channel catfish are sensitive to low dissolved oxygen during 2- or 3-week exposures. Survival at 25°C was slightly reduced at 5 mg/l and significantly reduced at 4.2 mg/l. At 28°C survival was slightly reduced at 3.8, 4.6, and 5.4 mg/l; total mortality occurred at 2.3 mg/l. At all reduced dissolved oxygen concentrations at both temperatures, embryo pigmentation was lighter, incubation period was extended, feeding was delayed, and growth was reduced. No effect of dissolved oxygen concentrations as low as 2.5 mg/l was seen on survival of embryonic and larval black crappie (Sieffert and Herman, 1977). Other tolerant species are the white bass and the white sucker, both of which evidenced adverse effect to embryo larval exposure only at dissolved oxygen concentrations of 1.8 and 1.2 mg/l, respectively (Sieffert et al., 1974; Sieffert and Spoor, 1974).

Data (Figure 1) on the effects of dissolved oxygen on the survival of embryonic and larval nonsalmonid fish show some species to be tolerant (largemouth bass, white sucker, black crappie, and white bass) and others nontolerant (channel catfish, walleye, northern pike, smallmouth bass). The latter three species are often included with salmonids in a grouping of sensitive coldwater fish; these data tend to support that placement.

F. Behavior

Largemouth bass in laboratory studies (Whitmore et al., 1960) showed a slight tendency to avoid concentrations of dissolved oxygen of 3.0 and 4.6 mg/l and a definite avoidance of 1.5 mg/l. Bluegills avoided a concentration of 1.5 mg/l but not higher concentrations. The environmental significance of such a response is unknown, but if large areas are deficient in dissolved oxygen this avoidance would probably not greatly enhance survival. Spoor (1977) exposed largemouth bass embryos and larvae to low dissolved oxygen for brief exposures of a few hours. At 23 to 24°C and 4 to 5 mg/l, the normally quiescent, bottom-dwelling yolk-sac larvae became very active and swam vertically to a few inches above the substrate. Such behavior in natural systems would probably cause significant losses due to predation and simple displacement from the nesting area.

G. Swimming

Effects of low dissolved oxygen on the swimming performance of largemouth bass were studied by Katz et al. (1959) and Dahlberg et al. (1968). The results in the former study were highly dependent upon season and temperature, with summer tests at 25°C finding no effect on continuous swimming for 24 hrs at 0.8 ft/sec unless dissolved oxygen concentrations fell below 2 mg/l. In the fall, at 20°C, no fish were able to swim for a day at 2.8 mg/l, and in the winter and 16° no fish swam for 24 hours at 5 mg/l. These results are consistent with those seen in salmonids in that swimming performance appears to be more sensitive to low dissolved oxygen at lower temperatures.

Dahlberg et al. (1968) looked at the effect of dissolved oxygen on maximum swimming speed at temperatures near 25°C. They reported slight effects (less than 10% reduction in maximum swimming speed) at concentrations between 3 and 4.5 mg/l, moderate reduction (16-20%) between 2 and 3 mg/l and severe reduction (30-50%) at 1 to 1.5 mg/l.

H. Field Studies

Ellis (1937) reported results of field studies conducted at 982 stations on freshwater streams and rivers during the months of June through September, 1930-1935. During this time, numerous determinations of dissolved oxygen concentrations were made. He concluded that 5 mg/l appeared to be the lowest concentration which may reasonably be expected to maintain varied warmwater fish species in good condition in inland streams. Ellis (1944) restated his earlier conclusion and also added that his study had included the measurement of dissolved oxygen concentrations at night and various seasons. He did not specify the frequency or proportion of diurnal or seasonal sampling, but the mean number of samples over the 5-year study was about seven samples per station.

Brinley (1944) discussed a 2-year biological survey of the Ohio River Basin. He concluded that in the zone where dissolved oxygen is between 3 and 5 mg/l the fish are more abundant than at lower concentrations, but show a tendency to sickness, deformity, and parasitization. The field results show that the concentration of 5 mg/l seems to represent a general dividing line between good and bad conditions for fish.

A three-year study of fish populations in the Wisconsin River indicated that sport fish (percids and centrarchids) constituted a significantly greater proportion of the fish population at sites having mean summer dissolved oxygen concentrations greater than 5 mg/l than at sites averaging below 5 mg/l (Coble, 1982). The differences could not be related to any observed habitat variables other than dissolved oxygen concentration.

These three field studies all indicate that increases in dissolved oxygen concentrations above 5 mg/l do not produce noteworthy improvements in the composition, abundance, or condition of non-salmonid fish populations, but that sites with dissolved oxygen concentrations below 5 mg/l have fish assemblages with increasingly poorer population characteristics as the dissolved oxygen concentrations become lower. It cannot be stressed too strongly that these field studies lack definition with respect to the actual exposure conditions experienced by the resident populations and the lack of good estimates for mean and minimum exposure concentrations over various periods precludes the establishment of numerical criteria based on these studies. The results of these semi-quantitative field studies are consistent with the criteria derived later in this document.

IV. Invertebrates

As stated earlier, there is a general paucity of information on the tolerance of the many forms of freshwater invertebrates to low dissolved oxygen. Most available data describe the relationship between oxygen concentration and oxygen consumption or short-term survival of aquatic larvae of insects. These data are further restricted by their emphasis on species representative of relatively fast-flowing mountain streams.

One rather startling feature of these data is the apparently high dissolved oxygen requirement for the survival of some species. Before extrapolating from these data one should be cautious in evaluating the respiratory mode(s) of the species, its natural environment, and the test environment. Thus, many nongilled species respire over their entire body surface while many other species are gilled. Either form is dependent upon the gradient of oxygen across the respiratory surface, a gradient at least partially dependent upon the rate of replacement of the water immediately surrounding the organism. Some insects, such as some members of the mayfly genus, Baetis, are found on rocks in extremely swift currents; testing their tolerance to low dissolved oxygen in laboratory apparatus at slower flow rats may contribute to their inability to survive at high dissolved oxygen concentrations. In addition, species of insects that utilize gaseous oxygen, either from bubbles or surface atmosphere, may not be reasonably tested for tolerance of hypoxia if their source of gaseous oxygen is deprived in the laboratory tests.

In spite of these potential problems, the dissolved oxygen requirements for the survival of many species of aquatic insects are almost certainly greater than those of most fish species. Early indication of the high dissolved oxygen requirements of some aquatic insects appeared in the research of Fox et al. (1937) who reported critical dissolved oxygen concentrations for mayfly nymphs in a static test system. Critical concentrations for six species ranged from 2.2 mg/l to 17 mg/l; three of the species had critical concentrations in excess of air saturation. These data suggest possible extreme sensitivity of some species and also the probability of unrealistic conditions of water flow. More recent studies in water flowing at 10 cm/sec indicate critical dissolved oxygen concentrations for four species of stonefly are between 7.3 and 4.8 mg/l (Benedetto, 1970).

In a recent study of 22 species of aquatic insects, Jacob et al. (1984) reported 2-5 hour LC50 values at unspecified "low to moderate" flows in a stirred exposure chamber, but apparently with no flow of replacement water. Tests were run at one or more of five temperatures from 12 to 30°C; some species were tested at only one temperature, others at as many as four. The median of the 22 species mean LC50s was about 3 mg/l, with eight species having an average LC50 below 1 mg/l and four in excess of 7 mg/l. The four most sensitive species were two mayfly species and two caddisfly species. The studies of Fox et al. (1937), Benedetto (1970), and Jacob et al. (1984) were all conducted with European species, but probably have general relevance to North American habitats. A similar oxygen consumption study of a North American stonefly (Kapoor and Griffiths, 1975) indicated a possible critical dissolved oxygen concentration of about 7 mg/l at a flow rate of 0.32 cm/sec and a temperature of 20°C.

One type of behavioral observation provides evidence of hypoxic stress in aquatic insects. As dissolved oxygen concentrations decrease, many species of aquatic insects can be seen to increase their respiratory movements, movements that provide for increased water flow over the respiratory surfaces. Fox and Sidney (1953) reported caddisfly respiratory movements over a range of dissolved oxygen from 9 to 1 mg/l. A dissolved oxygen decrease to 5 mg/l doubled the number of movements and at 1 to 2 mg/l the increase was 3- to 4-fold.

Similar data were published by Knight and Gaufin (1963) who studied a stonefly common in the western United States. Significant increases occurred below 5 mg/l at 16°C and below 2 mg/l at 10°C. Increases in movements occurred at higher dissolved oxygen concentrations when water flow was 1.5 cm/sec than 7.6 cm/sec, again indicating the importance of water flow rate on the respiration of aquatic insects. A subsequent paper by Knight and Gaufin (1965) indicated that species of stonefly lacking gills are more sensitive to low dissolved oxygen than are gilled forms.

Two studies that provide the preponderance of the current data on the acute effects of low dissolved oxygen concentrations on aquatic insects are those of Gaufin (1973) and Nebeker (1972) which together provide reasonable 96-hr LC50 dissolved oxygen concentrations for 26 species of aquatic insects (Table 6). The two studies contain variables that make them difficult to compare or evaluate fully. Test temperatures were 6.4°C in Gaufin's study and 18.5°C in Nebeker's. Gaufin used a vacuum degasser while Nebeker used a 30-foot stripping column that probably produced an unknown degree of supersaturation with nitrogen. The water velocity is not given in either paper, although flow rates are given but test chamber dimensions are not clearly specified. The overall similarity of the test results suggests that potential supersaturation and lower flow volume in Nebeker's tests did not have a significant effect on the results.

Because half of the insect species tested had 96-h LC50 dissolved oxygen concentrations between 3 and 4 mg/l it appears that these species (collected in Montana and Minnesota) would require at least 4 mg/l dissolved oxygen to ensure their survival. The two most sensitive species represent surprisingly diverse habitats, Ephemerella doddsi is found in swift rocky streams and has an LC50 of 5.2 mg/l while the pond mayfly, Callibaetis montanus, has an LC50 of 4.4 mg/l. It is possible that the test conditions represented too slow a flow for E. doddsi and too stressful flow conditions for C. montanus.

Table 6. Acutely lethal concentrations of dissolved oxygen to aquatic insects.

Species	96-h LC50 (mg/l)	Source*
Stonefly		
Acroneuria pacifica	1.6 (H)**	G
Acroneuria lycorias	3.6	N
Acrynopteryx aurea	3.3 (H)	G
Arcynopteryx parallela	< 2 (H)	G
Diura knowltoni	3.6 (L)	G
Nemoura cinctipes	3.3 (H)	G
Pteronarcys californica	3.9 (L)	G
Pteronarcys californica	3.2 (H)	G
Pteronarcys dorsata	2.2	N
Pteronarcella badia	2.4 (H)	G
Mayfly		
Baetisca laurentina	3.5	N
Callibaetis montanus	4.4 (L)	G
Ephemerella doddsi	5.2 (L)	G
Ephemerella grandis	3.0 (H)	G
Ephemerella subvaria	3.9	N
Hexagenia limbata	1.8 (H)	G
Hexagenia limbata	1.4	N
Leptophlebia nebulosa	2.2	N
Caddisfly		
Brachycentrus occidentalis	< 2 (L)	G
Drusinus sp.	1.8 (H)	G
Hydropsyche sp.	3.6 (L)	G
Hydropsyche betteri	2.9 (21°C)	N
Hydropsyche betteri	2.6 (18.5°C)	N
Hydropsyche betteri	2.3 (17°C)	N
Hydropsyche betteri	1.0 (10°C)	N
Lepidostoma sp.	< 3 (H)	G
Limnophilus ornatus	3.4 (L)	G
Neophylax sp.	3.8 (L)	G
Neothremma alicia	1.7 (L)	G
Diptera		
Simulium vittatum	3.2 (L)	G
Tanytarsus dissimilis	< 0.6	N

* G = Gaufin (1973) -- all tests at 6.4°C.
N = Nebeker (1972) -- all tests at 18.5°C except as noted/flow 125 ml/min.

** H = high flow (1000 ml/min); L = low flow (500 ml/min).

Other freshwater invertebrates have been subjected to acute hypoxic stress and their LC50 values determined. Gaufin (1973) reported a 96-h LC50 for the amphipod Gammarus limnaeus of < 3 mg/l. Four other crustaceans were studied by Sprague (1963) who reported the following 24-h LC50s: 0.03 mg/l, Asellus intermedius; 0.7 mg/l, Hyalella azteca; 2.2 mg/l, Gammarus pseudolimnaeus; and 4.3 mg/l, Gammarus fasciatus. The range of acute sensitivities of these species appears similar to that reported for aquatic insects.

There are few long-term studies of freshwater invertebrate tolerance to low dissolved oxygen concentrations. Both Gaufin (1973) and Nebeker (1972) conducted long-term survival studies with insects, but both are questioned because of starvation and potential nitrogen supersaturation, respectively. Gaufin's data for eight Montana species and 17 Utah species suggest that 4.9 mg/l and 3.3 mg/l, respectively, would provide for 50 percent survival for from 10 to 92 days. Nebeker lists 30-d LC50 values for five species, four between 4.4 and 5.0 mg/l and one < 0.5 mg/l. Overall, these data indicate that prolonged exposure to dissolved oxygen concentrations below 5 mg/l would have deterimental effects on a large proportion of the aquatic insects common in areas like Minnesota, Montana, and Utah. Information from other habitat types and geographic locations would provide a broader picture of invertebrate dissolved oxygen requirements.

A more classic toxicological protocol was used by Homer and Waller (1983) in a study of the effects of low dissolved oxygen on Daphna magna. In a 26-d chronic exposure test, they reported that 1.8 mg/l significantly reduced fecundity and 2.7 mg/l caused a 17 percent reduction in final weight of adults. No effect was seen at 3.7 mg/l.

In summarizing the state of knowledge regarding the relative sensitivity of fish and invertebrates to low dissolved oxygen, it seems that some species of insects and other crustaceans are killed at concentrations survived by all species of fish tested. Thus, while most fish will survive exposure to 3 mg/l, many species of invertebrates are killed by concentrations as high as 4 mg/l. The extreme sensitivity of a few species of aquatic inects may be an artifact of the testing environment. Those sensitive species common to swift flowing, coldwater streams may require very high concentrations of dissolved oxygen. On the other hand, those stream habitats are probably among the least likely to suffer significant dissolved oxygen depletion.

Long-term impacts of hypoxia are less well known for invertebrates than for fish. Concentrations adequate to avoid impairment of fish production probably will provide reasonable protection for invertebrates as long as lethal concentrations are avoided.

V. Other Considerations

A. Effects of Fluctuations

Natural dissolved oxygen concentrations fluctuate on a seasonal and daily basis, while in most laboratory studies the oxygen levels are held essentially constant. In two studies on the effects of daily oxygen cycles the authors concluded that growth of fish fed unrestricted rations was markedly less than would be estimated from the daily mean dissolved oxygen concentrations

(Fisher, 1963; Whitworth, 1968). The growth of these fish was only slightly above that attainable during constant exposure to the minimum concentrations of the daily cycles. A diurnal dissolved oxygen pulse to 3 mg/l for 8 hours per day for 9 days, with a concentration of 8.3 mg/l for the remainder of the time, produced a significant stress pattern in the serum protein fractions of bluegill and largemouth bass but not yellow bullhead (Bouck and Ball, 1965). During periods of low dissolved oxygen the fish lost their natural color, increased their ventilation rate, and remained very quiet. At these times food was ignored. Several times, during the low dissolved oxygen concentration part of the cycle, the fish vomited food which they had eaten as much as 12 hours earlier. After comparable exposure of the rock bass, Bouck (1972) observed similar results on electrophoretic patterns and feeding behavior.

Stewart et al. (1967) exposed juvenile largemouth bass to patterns of diurnally-variable dissolved oxygen concentrations with daily minima near 2 mg/l and daily maxima from 4 to 17 mg/l. Growth under any fluctuation pattern was almost always less than the growth that presumably would have occurred had the fish been held at a constant concentration equal to the mean concentration.

Carlson et al. (1980) conducted constant and diurnally fluctuating exposures with juvenile channel catfish and yellow perch. At mean constant concentrations of 3.5 mg/l or less, channel catfish consumed less food and growth was significantly reduced. Growth of this species was not reduced at fluctuations from about 6.2 to 3.6 and 4.9 to 2 mg/l, but was significantly impaired at a fluctuation from about 3.1 to 1 mg/l. Similarly, at mean constant concentrations near 3.5 mg/l, yellow perch consumed less food but growth was not impaired until concentrations were near 2 mg/l. Growth was not affected by fluctuations from about 3.8 to 1.4 mg/l. No dissolved oxygen-related mortalities were observed. In both the channel catfish and the yellow perch experiments, growth rates during the tests with fluctuating dissolved oxygen were considerably below the rate attained in the constant exposure tests. As a result, the fluctuating and constant exposures could not be compared. Growth would presumably have been more sensitive in the fluctuating tests if there had been higher rates of control growth.

Mature black crappies were exposed to constant and fluctuating dissolved oxygen concentrations (Carlson and Herman, 1978). Constant concentrations were near 2.5, 4, 5.5, and 7 mg/l and fluctuating concentrations ranged from 0.8 to 1.9 mg/l above and below these original concentrations. Successful spawning occurred at all exposures except the fluctuation between 1.8 and 4.1 mg/l.

In considering daily or longer-term cyclic exposures to low dissolved oxygen concentrations, the minimum values may be more important than the mean levels. The importance of the daily minimum as a determinant of growth rate is common to the results of Fisher (1963), Stewart (1967), and Whitworth (1968). Since annual low dissolved oxygen concentrations normally occur during warmer months, the significance of reduced growth rates during the period in question must be considered. If growth rates are normally low, then the effects of low dissolved oxygen concentration on growth could be minimal; if normal growth rates are high, the effects could be significant, especially if the majority of the annual growth occurs during the period in question.

B. Temperature and Chemical Stress

When fish were exposed to lethal temperatures, their survival times were reduced when the dissolved oxygen concentration was lowered from 7.4 to 3.8 mg/l (Alabaster and Welcomme, 1962). Since high temperature and low dissolved oxygen commonly occur together in natural environments, this likelihood of additive or synergistic effects of these two potential stresses is a most important consideration.

High temperatures almost certainly increase the adverse effects of low dissolved oxygen concentrations. However, the spotty, irregular acute lethality data base provides little basis for quantitative, predictive analysis. Probably the most complete study is that on rainbow trout, perch, and roach conducted by Downing and Merkens (1957). Because their study was spread over an 18-month period, seasonal effects could have influenced the effects at the various test temperatures. Over a range from approximately 10 to 20°C, the lethal dissolved oxygen concentrations increased by an average factor of about 2.6, ranging from 1.4 to 4.1 depending on fish species tested and test duration. The influence of temperature on chronic effects of low dissolved oxygen concentrations are not well known, but requirements for dissolved oxygen probably increase to some degree with increasing temperature. This generalization is supported by analysis of salmon studies reported by Warren et al. (1973) and the largemouth bass studies of Brake (1972).

Because most laboratory tests are conducted at temperatures near the mid-range of a species temperature tolerance, criteria based on these test data will tend to be under-protective at higher temperatures and over-protective at lower temperatures. Concern for this temperature effect was a consideration in establishing these criteria, especially in the establishing of those criteria intended to prevent short-term lethal effects.

A detailed discussion and model for evaluating interactions among temperature, dissolved oxygen, ammonia, fish size, and ration on the resulting growth of individual fish (Cuenco et al., 1985a,b,c) provides an excellent, in-depth evaluation of potential effects of dissolved oxygen on fish growth.

Several laboratory studies evaluated the effect of reduced dissolved oxygen concentrations on the toxicity of various chemicals, some of which occur commonly in oxygen-demanding wastes. Lloyd (1961) observed that the toxicity of zinc, lead, copper, and monohydric phenols was increased at dissolved oxygen concentrations as high as approximately 6.2 mg/l as compared to 9.1 mg/l. At 3.8 mg/l, the toxic effect of these chemicals was even greater. The toxicity of ammonia was enhanced by low dissolved oxygen more than that of other toxicants. Lloyd theorized that the increases in toxicity of the chemicals were due to increased ventilation at low dissolved oxygen concentrations; as a consequence of increased ventilation, more water, and therefore more toxicant, passes the fish's gills. Downing and Merkens (1955) reported that survival times of rainbow trout at lethal ammonia concentrations increased markedly over a range of dissolved oxygen concentrations from 1.5 to 8.5 mg/l. Ninety-six-hr LC50 values for rainbow trout indicate that ammonia became more toxic with decreasing dissolved oxygen concentrations from 8.6 to 2.6 mg/l (Thurston et al., 1981). The maximum increase in toxicity was by about a factor of 2. They also compared ammonia LC50 values at reduced dissolved oxygen concentrations after 12, 24, 48, and 72 hrs. The shorter the time period, the more pronounced the positive relationship between the LC50 and dissolved oxygen concentration. The authors recommended that dissolved oxygen standards for the protection of salmonids should reflect background concentrations of ammonia which may be present and the likelihood of temporary increases in those concentrations. Adelman and Smith (1972) observed that decreasing dissolved oxygen concentrations increased the toxicity of hydrogen sulfide to goldfish. When the goldfish were acclimated to the reduced dissolved oxygen concentration before the exposure to hydrogen sulfide began, mean 96-hr LC50 values were 0.062 and 0.048 mg/l at dissolved oxygen concentrations of 6 and 1.5 mg/l, respectively. When there was no prior acclimation, the LC50 values were 0.071 and 0.053 mg/l at the same dissolved oxygen concentrations. These results demonstrated a less than doubling in toxicity of hydrogen sulfide and little difference with regard to prior acclimation to reduced dissolved oxygen concentrations. Cairns and Scheier (1957) observed that bluegills were less tolerant to zinc, naphthenic acid, and potassium cyanide at periodic low dissolved oxygen concentrations. Pickering (1968) reported that an increased mortality of bluegills exposed to zinc resulted from the added stress of low dissolved oxygen concentrations. The difference in mean LC50 values between low (1.8 mg/l) and high (5.6 mg/l) dissolved oxygen concentrations was a factor of 1.5.

Interactions between other stresses and low dissolved oxygen concentrations can greatly increase mortality of trout larvae. For example, sublethal concentrations of pentachlorophenol and oxygen combined to produce 100 percent mortality of trout larvae held at an oxygen concentration of 3 mg/l (Chapman and Shumway, 1978). The survival of chinook salmon embryos and larvae reared at marginally high temperatures was reduced by any reduction in dissolved oxygen, especially at concentrations below 7 mg/l (Eddy, 1972).

In general, the occurrence of toxicants in the water mass, in combination with low dissolved oxygen concentration, may lead to a potentiation of stress responses on the part of aquatic organisms (Davis, 1975a,b). Doudoroff and Shumway (1970) recommended that the disposal of toxic pollutants must be controlled so that their concentrations would not be unduly harmful at prescribed, acceptable concentrations of dissolved oxygen, and these acceptable dissolved oxygen concentrations should be independent of existing or highest permitted concentrations of toxic wastes.

C. Disease Stress

In a study of 5 years of case records at fish farms, Meyer (1970) observed that incidence of infection with *Aeromonas liquefasciens* (a common bacterial pathogen of fish) was most prevalent during June, July, and August. He considered low oxygen stress to be a major factor in outbreaks of *Aeromonas* disease during summer months. Haley et al. (1967) concluded that a kill of American and threadfin shad in the San Joaquin River occurred as a result of *Aeromonas* infection the day after the dissolved oxygen was between 1.2 and 2.6 mg/l. In this kill the lethal agent was *Aeromonas* but the additional stress of the low dissolved oxygen may have been a significant factor.

Wedemeyer (1974) reviewed the role of stress as a predisposing factor in fish diseases and concluded that facultative fish pathogens are continuously present in most waters. Disease problems seldom occur, however, unless environmental quality and the host defense systems of the fish also deteriorate. He listed furunculosis, Aeromonad and Pseudomonad hemorrhagic septicemia, and vibriosis as diseases for which low dissolved oxygen is one environmental factor predisposing fish to epizootics. He stated that to optimize fish health, dissolved oxygen concentrations should be 6.9 mg/l or higher. Snieszko (1974) also stated that outbreaks of diseases are probably more likely if the occurrence of stress coincides with the presence of pathogenic microorganisms.

VI. Conclusions

The primary determinant for the criteria is laboratory data describing effect on growth, with developmental rate and survival included in embryo and larval production levels. For the purpose of deriving criteria, growth in the laboratory and production in nature are considered equally sensitive to low dissolved oxygen. Fish production in natural communities actually may be significantly more, or less, sensitive than growth in the laboratory, which represents only one simplified facet of production.

The dissolved oxygen criteria are based primarily on data developed in the laboratory under conditions which are usually artificial in several important respects. First, they routinely preclude or minimize most environmental stresses and biological interactions that under natural conditions are likely to increase, to a variable and unknown extent, the effect of low dissolved oxygen concentrations. Second, organisms are usually given no opportunity to acclimate to low dissolved oxygen concentrations prior to tests nor can they avoid the test exposure. Third, food availability is unnatural because the fish have easy, often unlimited, access to food without significant energy expenditure for search and capture. Fourth, dissolved oxygen concentrations are kept nearly constant so that each exposure represents both a minimum and an average concentration. This circumstance complicates application of the data to natural systems with fluctuating dissolved oxygen concentrations.

Considering the latter problem only, if the laboratory data are applied directly as minimum allowable criteria, the criteria will presumably be higher than necessary because the mean dissolved oxygen concentration will often be significantly higher than the criteria. If applied as a mean, the criteria could allow complete anoxia and total mortality during brief periods of very low dissolved oxygen or could allow too many consecutive daily minima near the lethal threshold. If only a minimum or a mean can be given as a general criterion, the minimum must be chosen because averages are too independent of the extremes.

Obviously, biological effects of low dissolved oxygen concentrations depend upon means, minima, the duration and frequency of the minima, and the period of averaging. In many respects, the effects appear to be independent of the maxima; for example, including supersaturated dissolved oxygen values in the average may produce mean dissolved oxygen concentrations that are misleadingly high and unrepresentative of the true biological stress of the dissolved oxygen minima.

Because most experimental exposures have been constant, data on the effect of exposure to fluctuating dissolved oxygen concentrations is sketchy. The few fluctuating exposure studies have used regular, repeating daily cycles of an on-off nature with 8 to 16 hours at low dissolved oxygen and the remainder of the 24 hr period at intermediate or high dissolved oxygen. This is an uncharacteristic exposure pattern, since most daily dissolved oxygen cycles are of a sinusoidal curve shape and not a square-wave variety.

The existing data allow a tentative theoretical dosing model for fluctuating dissolved oxygen only as applied to fish growth. The EPA believes that the data of Stewart et al. (1967) suggest that effects on growth are reasonably represented by calculating the mean of the daily cycle using as a maximum value the dissolved oxygen concentration which represents the threshold effect concentration during continuous exposure tests. For example, with an effect threshold of 6 mg/l, all values in excess of 6 mg/l should be averaged as though they were 6 mg/l. Using this procedure, the growth effects appear to be a reasonable function of the mean, as long as the minimum is not lethal. Lethal thresholds are highly dependent upon exposure duration, species, age, life stage, temperature, and a wide variety of other factors. Generally the threshold is between 1 and 3 mg/l.

A most critical and poorly documented aspect of a dissolved oxygen criterion is the question of acceptable and unacceptable minima during dissolved oxygen cycles of varying periodicity. Current ability to predict effects of exposure to a constant dissolved oxygen level is only fair; the effects of regular, daily dissolved oxygen cycles can only be poorly estimated; and predicting the effects of more stochastic patterns of dissolved oxygen fluctuations requires an ability to integrate constant and cycling effects.

Several general conclusions result from the synthesis of available field and laboratory data. Some of these conclusions differ from earlier ones in the literature, but the recent data discussed in this document have provided additional detail and perspective.

- Naturally-occurring dissolved oxygen concentrations may occasionally fall below target criteria levels due to a combination of low flow, high temperature, and natural oxygen demand. These naturally-occurring conditions represent a normal situation in which the productivity of fish or other aquatic organisms may not be the maximum possible under ideal circumstances, but which represent the maximum productivity under the particular set of natural conditions. Under these circumstances the numerical criteria should be considered unattainable, but naturally-occurring conditions which fail to meet criteria should not be interpreted as violations of criteria. Although further reductions in dissolved oxygen may be inadvisable, effects of any reductions should be compared to natural ambient conditions and not to ideal conditions.

- Situations during which attainment of appropriate criteria is most critical include periods when attainment of high fish growth rates is a priority, when temperatures approach upper-lethal levels, when pollutants are present in near-toxic quantities, or when other significant stresses are suspected.

- Reductions in growth rate produced by a given low dissolved oxygen concentration are probably more severe as temperature increases. Even during periods when growth rates are normally low, high temperature stress increases the sensitivity of aquatic organisms to disease and toxic pollutants, making the attainment of proper dissolved oxygen criteria particularly important. For these reasons, periods of highest temperature represent a critical portion of the year with respect to dissolved oxygen requirements.

- In salmonid spawning habitats, intergravel dissolved oxygen concentrations are significantly reduced by respiration of fish embryos and other organisms. Higher water column concentrations of dissolved oxygen are required to provide protection of fish embryos and larvae which develop in the intergravel environment. A 3 mg/l difference is used in the criteria to account for this factor.

- The early life stages, especially the larval stage, of non-salmonid fish are usually most sensitive to reduced dissolved oxygen stress. Delayed development, reduced larval survival, and reduced larval and post-larval growth are the observed effects. A separate early life stage criterion for non-salmonids is established to protect these more sensitive stages and is to apply from spawning through 30 days after hatching.

- Other life stages of salmonids appear to be somewhat more sensitive than other life stages of the non-salmonids, but this difference, resulting in a 1.0 mg/l difference in the criteria for other life stages, may be due to a more complete and precise data base for salmonids. Also, this difference is at least partially due to the colder water temperatures at which salmonid tests are conducted and the resultant higher dissolved oxygen concentration in oxygen-saturated control water.

- Few appropriate data are available on the effects of reduced dissolved oxygen on freshwater invertebrates. However, historical concensus states that, if all life stages of fish are protected, the invertebrate communities, although not necessarily unchanged, should be adequately protected. This is a generalization to which there may be exceptions of environmental significance. Acutely lethal concentrations of dissolved oxygen appear to be higher for many aquatic insects than for fish.

- Any dissolved oxygen criteria should include absolute minima to prevent mortality due to the direct effects of hypoxia, but such minima alone may not be sufficient protection for the long-term persistence of sensitive populations under natural conditions. Therefore, the criteria minimum must also provide reasonable assurance that regularly repeated or prolonged exposure for days or weeks at the allowable minimum will avoid significant physiological stress of sensitive organisms.

Several earlier dissolved oxygen criteria were presented in the form of a family of curves (Doudoroff and Shumway, 1970) or equations (NAS/NAE, 1973) which yielded various dissolved oxygen requirements depending on the qualitative degree of fishery protection or risk deemed suitable at a given site. Although dissolved oxygen concentrations that risk significant loss of fishery production are not consistent with the intent of water quality criteria, a qualitative protection/risk assessment for a range of dissolved oxygen concentrations has considerable value to resource managers. Using qualitative descriptions similar to those presented in earlier criteria of Doudoroff and Shumway (1970) and Water Quality Criteria 1972 (NAS/NAE, 1973), four levels of risk are listed below:

No Production Impairment. Representing nearly maximal protection of fishery resources.

Slight Production Impairment. Representing a high level of protection of important fishery resources, risking only slight impairment of production in most cases.

Moderate Production Impairment. Protecting the persistence of existing fish populations but causing considerable loss of production.

Severe Production Impairment. For low level protection of fisheries of some value but whose protection in comparison with other water uses cannot be a major objective of pollution control.

Selection of dissolved oxygen concentrations equivalent to each of these levels of effect requires some degree of judgment based largely upon examination of growth and survival data, generalization of response curve shape, and assumed applicability of laboratory responses to natural populations. Because nearly all data on the effects of low dissolved oxygen on aquatic organisms relate to continuous exposure for relatively short duration (hours to weeks), the resultant dissolved oxygen concentration-biological effect estimates are most applicable to essentially constant exposure levels, although they may adequately represent mean concentrations as well.

The production impairment values are necessarily subjective, and the definitions taken from Doudoroff and Shumway (1970) are more descriptive than the accompanying terms "slight," "moderate," and "severe." The impairment values for other life stages are derived predominantly from the growth data summarized in the text and tables in Sections II and III. In general, slight, moderate, and severe impairment are equivalent to 10, 20, and 40 percent growth impairment, respectively. Growth impairment of 50 percent or greater is often accompanied by mortality, and conditions allowing a combination of severe growth impairment and mortality are considered as no protection.

Production impairment levels for early life stages are quite subjective and should be viewed as convenient divisions of the range of dissolved oxygen concentrations between the acute mortality limit and the no production impairment concentrations.

Production impairment values for invertebrates are based on survival in both long-term and short-term studies. There are no studies of warmwater species and few of lacustrine species.

The following is a summary of the dissolved oxygen concentrations (mg/l) judged to be equivalent to the various qualitative levels of effect described earlier; the value cited as the acute mortality limit is the minimum dissolved oxygen concentration deemed not to risk direct mortality of sensitive organisms:

1. Salmonid Waters

a. Embryo and Larval Stages

- No Production Impairment = 11* (8)
- Slight Production Impairment = 9* (6)
- Moderate Production Impairment = 8* (5)
- Severe Production Impairment = 7* (4)
- Limit to Avoid Acute Mortality = 6* (3)

(* Note: These are water column concentrations recommended to achieve the required intergravel dissolved oxygen concentrations shown in parentheses. The 3 mg/l difference is discussed in the criteria document.)

b. Other Life Stages

- No Production Impairment = 8
- Slight Production Impairment = 6
- Moderate Production Impairment = 5
- Severe Production Impairment = 4
- Limit to Avoid Acute Mortality = 3

2. Nonsalmonid Waters

a. Early Life Stages

- No Production Impairment = 6.5
- Slight Production Impairment = 5.5
- Moderate Production Impairment = 5
- Severe Production Impairment = 4.5
- Limit to Avoid Acute Mortality = 4

b. Other Life Stages

- No Production Impairment = 6
- Slight Production Impairment = 5
- Moderate Production Impairment = 4
- Severe Production Impairment = 3.5
- Limit to Avoid Acute Mortality = 3

3. Invertebrates

- No Production Impairment = 8
- Some Production Impairment = 5
- Acute Mortality Limit = 4

Added Note

Just prior to final publication of this criteria document, a paper appeared (Sowden and Power, 1985) that provided an interesting field validation of the salmonid early life stage criterion and production impairment estimates. A total of 19 rainbow trout redds were observed for a number of parameters including percent survival of embryos, dissolved oxygen concentration, and calculated intergravel water velocity. The results cannot be considered a rigorous evaluation of the criteria because of the paucity of dissolved oxygen determinations per redd (2-5) and possible inaccuracies in determining percent survival and velocity. Nevertheless, the qualitative validation is striking.

The generalization drawn from Coble's (1961) study that good survival occurred when mean intergravel dissolved oxygen concentrations exceeded 6.0 mg/l and velocity exceeded 20 cm/hr was confirmed; 3 of the 19 redds met this criterion and averaged 29 percent embryo survival. The survival in the other 16 redds averaged only 3.6 percent. The data from the study are summarized in Table 7. The critical intergravel water velocity from this study appears to be about 15 cm/hr. Below this velocity even apparently good dissolved oxygen

Table 7. Survival of rainbow trout embryos as a function of intergravel dissolved oxygen concentration and water velocity (Sowden and Power, 1985) as compared to dissolved oxygen concentrations established as criteria or estimated as producing various levels of production impairment.

Criteria Estimates	Dissolved Oxygen Concentration mg/l		Percent Survival	Water Velocity, cm/hr	Mean Survival (Flow > 15 cm/hr)
	Mean	Minimum			
Exceeded Criteria	8.9	8.0	22.1	53.7	
	7.7	7.0	43.5	83.2	29.0
	7.0	6.4	1.1	9.8	
	6.9	5.4	21.3	20.6	
Slight Production Impairment	7.4	4.1	0.5	7.2	
	7.1	4.3	21.5	16.3	
	6.7	4.5	4.3	5.4	15.6
	6.4	4.2	0.3	7.9	
	6.0	4.2	9.6	17.4	
Moderate Production Impairment	5.8	3.1	13.4	21.6	
	5.3	3.6	5.6	16.8	6.5
	5.2	3.9	0.4	71.0	
Severe Production Impairment	4.6	4.1	0.9	18.3	0.9
	4.2	3.3	0.0	0.4	
Acute Mortality	3.9	2.9	0.0	111.4	
	3.6	2.1	0.0	2.6	
	2.7	1.2	0.0	4.2	0.0
	2.4	0.8	0.0	1.1	
	2.0	0.8	0.0	192.0	

characteristics do not produce reasonable survival. At water velocities in excess of 15 cm/hr the average percent survival in the redds that had dissolved oxygen concentrations that met the criteria was 29.0 percent. There was no survival in redds that had dissolved oxygen minima below the acute mortality limit. Percent survival in redds with greater than 15 cm/hr flow averaged 15.6, 6.5, and 0.9 percent for redds meeting slight, moderate, and severe production impairment levels, respectively.

Based on an average redd of 1000 eggs, these mean percent survivals would be equivalent to 290, 156, 65, 9, and 0 viable larvae entering the environment to produce food for other fish, catch for fishermen, and eventually a new generation of spawners to replace the parents of the embryos in the redd. Whether or not these survival numbers ultimately represent the impairment definitions is moot in the light of further survival and growth uncertainties, but the quantitative field results and the qualitative and quantitative impairment and criteria values are surprisingly similar.

VII. National Criterion

The national criteria for ambient dissolved oxygen concentrations for the protection of freshwater aquatic life are presented in Table 8. The criteria are derived from the production impairment estimates on the preceding page which are in turn based primarily upon growth data and information on temperature, disease, and pollutant stresses. The average dissolved oxygen concentrations selected are values 0.5 mg/l above the slight production impairment values and represent values between no production impairment and slight production impairment. Each criterion may thus be viewed as an estimate of the threshold concentration below which detrimental effects are expected.

Criteria for coldwater fish are intended to apply to waters containing a population of one or more species in the family Salmonidae (Bailey et al., 1970) or to waters containing other coldwater or coolwater fish deemed by the user to be closer to salmonids in sensitivity than to most warmwater species. Although the acute lethal limit for salmonids is at or below 3 mg/l, the coldwater minimum has been established at 4 mg/l because a significant proportion of the insect species common to salmonid habitats are less tolerant of acute exposures to low dissolved oxygen than are salmonids. Some coolwater species may require more protection than that afforded by the other life stage criteria for warmwater fish and it may be desirable to protect sensitive coolwater species with the coldwater criteria. Many states have more stringent dissolved oxygen standards for cooler waters, waters that contain either salmonids, nonsalmonid coolwater fish, or the sensitive centrarchid, the smallmouth bass. The warmwater criteria are necessary to protect early life stages of warmwater fish as sensitive as channel catfish and to protect other life stages of fish as sensitive as largemouth bass. Criteria for early life stages are intended to apply only where and when these stages occur. These criteria represent dissolved oxygen concentrations which EPA believes provide a reasonable and adequate degree of protection for freshwater aquatic life.

The criteria do not represent assured no-effect levels. However, because the criteria represent worst case conditions (i.e., for wasteload allocation and waste treatment plan design), conditions will be better than the criteria

Table 8. Water quality criteria for ambient dissolved oxygen concentration.

	Coldwater Criteria		Warmwater Criteria	
	Early Life Stages[1,2]	Other Life Stages	Early Life Stages[2]	Other Life Stages
30 Day Mean	NA[3]	6.5	NA	5.5
7 Day Mean	9.5 (6.5)	NA	6.0	NA
7 Day Mean Minimum	NA	5.0	NA	4.0
1 Day Minimum[4,5]	8.0 (5.0)	4.0	5.0	3.0

[1] These are water column concentrations recommended to achieve the required intergravel dissolved oxygen concentrations shown in parentheses. The 3 mg/l differential is discussed in the criteria document. For species that have early life stages exposed directly to the water column, the figures in parentheses apply.

[2] Includes all embryonic and larval stages and all juvenile forms to 30-days following hatching.

[3] NA (not applicable).

[4] For highly manipulatable discharges, further restrictions apply (see page 37)

[5] All minima should be considered as instantaneous concentrations to be achieved at all times.

nearly all the time at most sites. In situations where criteria conditions are just maintained for considerable periods, the criteria represent some risk of production impairment. This impairment would probably be slight, but would depend on innumerable other factors. If slight production impairment or a small but undefinable risk of moderate production impairment is unacceptable, then continuous exposure conditions should use the no production impairment values as means and the slight production impairment values as minima.

The criteria represent annual worst case dissolved oxygen concentrations believed to protect the more sensitive populations of organisms against potentially damaging production impairment. The dissolved oxygen concentrations in the criteria are intended to be protective at typically high seasonal environmental temperatures for the appropriate taxonomic and life stage classifications, temperatures which are often higher than those used in the research from which the criteria were generated, especially for other than early life stages.

Where natural conditions alone create dissolved oxygen concentrations less than 110 percent of the applicable criteria means or minima or both, the minimum acceptable concentration is 90 percent of the natural concentration. These values are similar to those presented graphically by Doudoroff and Shumway (1970) and those calculated from Water Quality Criteria 1972 (NAS/NAE, 1973). Absolutely no anthropogenic dissolved oxygen depression in the potentially lethal area below the 1-day minima should be allowed unless special care is taken to ascertain the tolerance of resident species to low dissolved oxygen.

If daily cycles of dissolved oxygen are essentially sinusoidal, a reasonable daily average is calculated from the day's high and low dissolved oxygen values. A time-weighted average may be required if the dissolved oxygen cycles are decidedly non-sinusoidal. Determining the magnitude of daily dissolved oxygen cycles requires at least two appropriately timed measurements daily, and characterizing the shape of the cycle requires several more appropriately spaced measurements.

Once a series of daily mean dissolved oxygen concentrations are calculated, an average of these daily means can be calculated (Table 9). For embryonic, larval, and early life stages, the averaging period should not exceed 7 days. This short time is needed to adequately protect these often

Table 9. Sample calculations for determining daily means and 7-day mean dissolved oxygen concentrations (30-day averages are calculated in a similar fashion using 30 days data).

Day	Dissolved Oxygen (mg/l) Daily Max.	Daily Min.	Daily Mean
1	9.0	7.0	8.0
2	10.0	7.0	8.5
3	11.0	8.0	9.5
4	12.0[a]	8.0	9.5[b]
5	10.0	8.0	9.0
6	11.0	9.0	10.0
7	12.0[a]	10.0	10.5[c]
Σ		57.0	65.0
1-day Minimum		7.0	
7-day Mean Minimum		8.1	
7-day Mean			9.3

[a] Above air saturation concentration (assumed to be 11.0 mg/l for this example).
[b] (11.0 + 8.0) ÷ 2.
[c] (11.0 +10.0) ÷ 2.

short duration, most sensitive life stages. Other life stages can probably be adequately protected by 30-day averages. Regardless of the averaging period, the average should be considered a moving average rather than a calendar-week or calendar-month average.

The criteria have been established on the basis that the maximum dissolved oxygen value actually used in calculating any daily mean should not exceed the air saturation value. This consideration is based primarily on analysis of studies of cycling dissolved oxygen and the growth of largemouth bass (Stewart et al., 1967), which indicated that high dissolved oxygen levels (> 6 mg/l) had no beneficial effect on growth.

During periodic cycles of dissolved oxygen concentrations, minima lower than acceptable constant exposure levels are tolerable so long as:

1. the average concentration attained meets or exceeds the criterion;

2. the average dissolved oxygen concentration is calculated as recommended in Table 9; and

3. the minima are not unduly stressful and clearly are not lethal.

A daily minimum has been included to make certain that no acute mortality of sensitive species occurs as a result of lack of oxygen. Because repeated exposure to dissolved oxygen concentrations at or near the acute lethal threshold will be stressful and because stress can indirectly produce mortality or other adverse effects (e.g., through disease), the criteria are designed to prevent significant episodes of continuous or regularly recurring exposures to dissolved oxygen concentrations at or near the lethal threshold. This protection has been achieved by setting the daily minimum for early life stages at the subacute lethality threshold, by the use of a 7-day averaging period for early life stages, by stipulating a 7-day mean minimum value for other life stages, and by recommending additional limits for manipulatable discharges.

The previous EPA criterion for dissolved oxygen published in Quality Criteria for Water (USEPA, 1976) was a minimum of 5 mg/l (usually applied as a 7Q10) which is similar to the current criterion minimum except for other life stages of warmwater fish which now allows a 7-day mean minimum of 4 mg/l. The new criteria are similar to those contained in the 1968 "Green Book" of the Federal Water Pollution Control Federation (FWPCA, 1968).

A. The Criteria and Monitoring and Design Conditions

The acceptable mean concentrations should be attained most of the time, but some deviation below these values would probably not cause significant harm. Deviations below the mean will probably be serially correlated and hence apt to occur on consecutive days. The significance of deviations below the mean will depend on whether they occur continuously or in daily cycles, the former being more adverse than the latter. Current knowledge regarding such deviations is limited primarily to laboratory growth experiments and by extrapolation to other activity-related phenomena.

Under conditions where large daily cycles of dissolved oxygen occur, it is possible to meet the criteria mean values and consistently violate the mean minimum criteria. Under these conditions the mean minimum criteria will clearly be the limiting regulation unless alternatives such as nutrient control can dampen the daily cycles.

The significance of conditions which fail to meet the recommended dissolved oxygen criteria depend largely upon five factors: (1) the duration of the event; (2) the magnitude of the dissolved oxygen depression; (3) the frequency of recurrence; (4) the proportional area of the site failing to meet the criteria; and (5) the biological significance of the site where the event occurs. Evaluation of an event's significance must be largely case- and site-specific. Common sense would dictate that the magnitude of the depression would be the single most important factor in general, especially if the acute value is violated. A logical extension of these considerations is that the event must be considered in the context of the level of resolution of the monitoring or modeling effort. Evaluating the extent, duration, and magnitude of an event must be a function of the spatial and temporal frequency of the data. Thus, a single deviation below the criterion takes on considerably less significance where continuous monitoring occurs than where sampling is comprised of once-a-week grab samples. This is so because based on continuous monitoring the event is provably small, but with the much less frequent sampling the event is not provably small and can be considerably worse than indicated by the sample.

The frequency of recurrence is of considerable interest to those modeling dissolved oxygen concentrations because the return period, or period between recurrences, is a primary modeling consideration contingent upon probabilities of receiving water volumes, waste loads, temperatures, etc. It should be apparent that return period cannot be isolated from the other four factors discussed above. Ultimately, the question of return period may be decided on a site-specific basis taking into account the other factors (duration, magnitude, areal extent, and biological significance) mentioned above. Future studies of temporal patterns of dissolved oxygen concentrations, both within and between years, must be conducted to provide a better basis for selection of the appropriate return period.

In conducting waste load allocation and treatment plant design computations, the choice of temperature in the models will be important. Probably the best option would be to use temperatures consistent with those expected in the receiving water over the critical dissolved oxygen period for the biota.

B. The Criteria and Manipulatable Discharges

If daily minimum ~~dissol~~ved oxygen concentrations are perfectly serially correlated, i.e., if the annual lowest daily minimum dissolved oxygen concentration is adjacent in time to the next lower daily minimum dissolved oxygen concentration and one of these two minima is adjacent to the third lowest daily minimum dissolved oxygen concentration, etc., then in order to meet the 7-day mean minimum criterion it is unlikely that there will be more than three or four consecutive daily minimum values below the acceptable 7-day mean minimum. Unless the dissolved oxygen pattern is extremely erratic, it is also unlikely that the lowest dissolved oxygen concentration will be appreciably below the acceptable 7-day mean minimum or that daily minimum values below the 7-day mean minimum will occur in more than one or two weeks each year. For some discharges, the distribution of dissolved oxygen concentrations can be manipulated to varying degrees. Applying the daily minimum to manipulatable discharges would allow repeated weekly cycles of minimum acutely acceptable dissolved oxygen values, a condition of probable stress and possible adverse biological effect. If risk of protection impairment is to be minimized, the application of the one day minimum criterion to manipulatable discharges should either limit the frequency of occurrence of values below the acceptable 7-day mean minimum or impose further limits on the extent of excursions below the 7-day mean minimum. For such controlled discharges, it is recommended that the occurrence of daily minima below the acceptable 7-day mean minimum be limited to 3 weeks per year or that the acceptable one-day minimum be increased to 4.5 mg/l for coldwater fish and 3.5 mg/l for warmwater fish. Such decisions could be site-specific based upon the extent of control, serial correlation, and the resource at risk.

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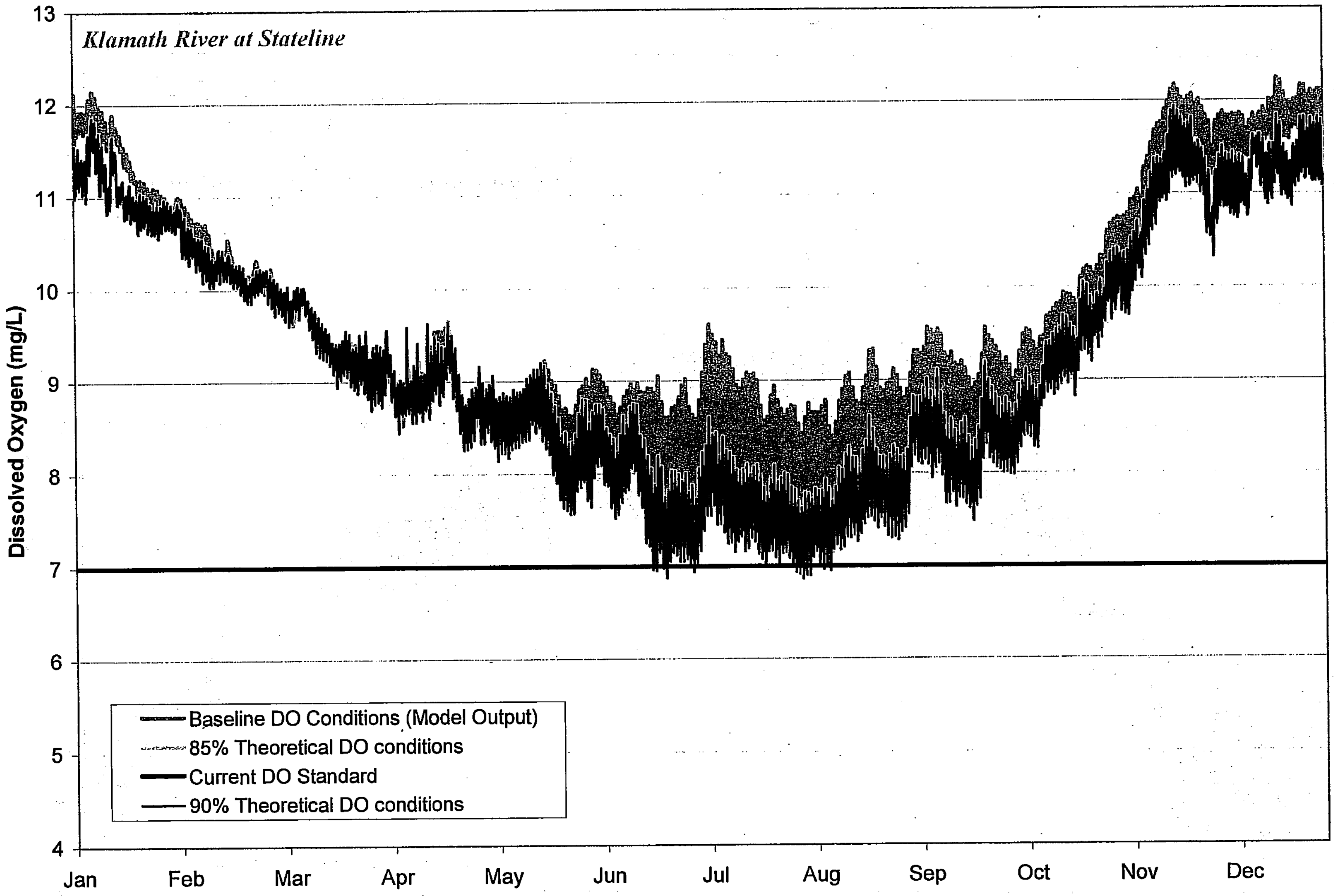
APPENDIX G


Klamath River at Stateline
Dissolved Oxygen (mg/L)
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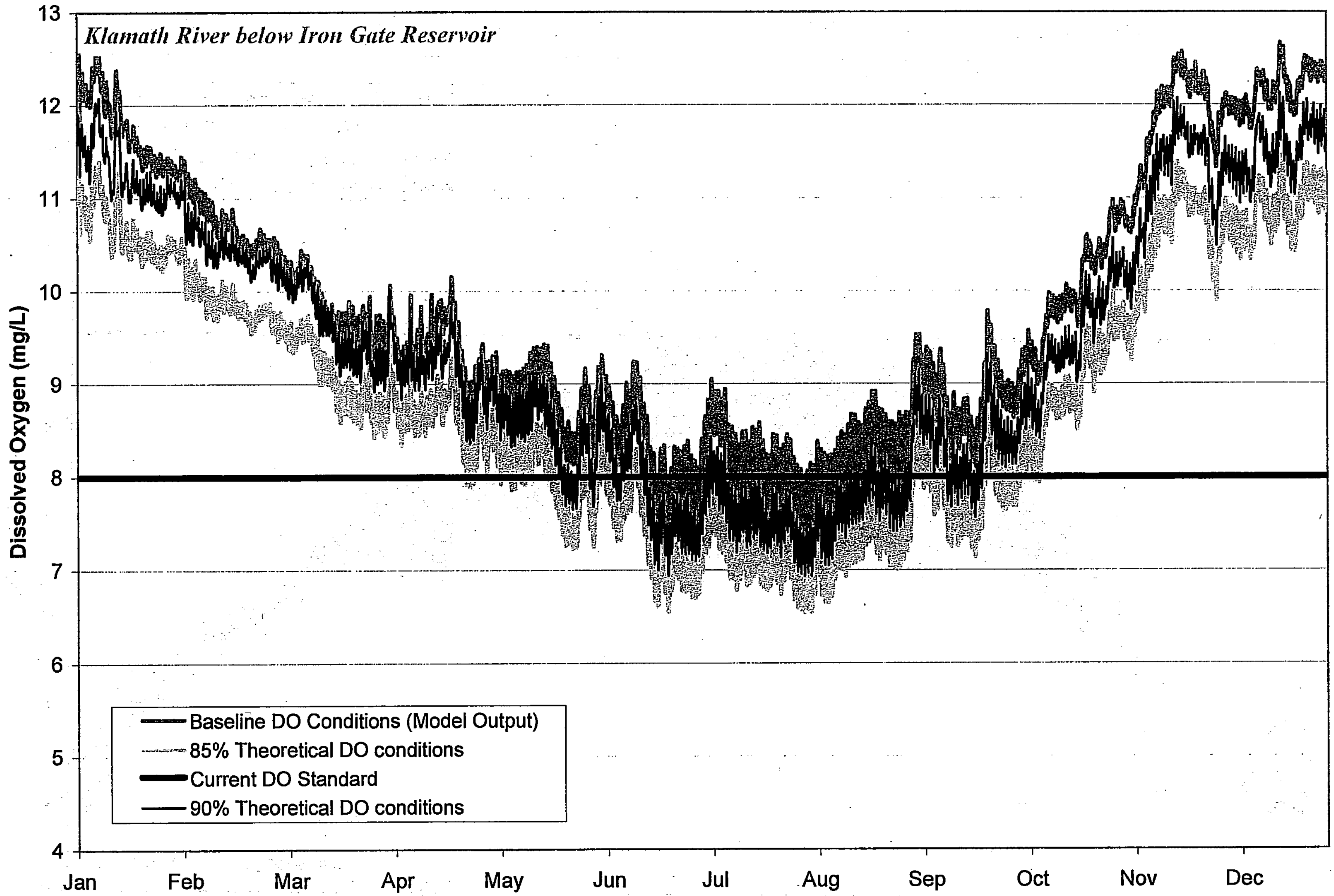
Dec
Baseline DO Conditions (Model Output)
85% Theoretical DO conditions
Current DO Standard
90% Theoretical DO conditions


Klamath River below Iron Gate Reservoir
Dissolved Oxygen (mg/L)
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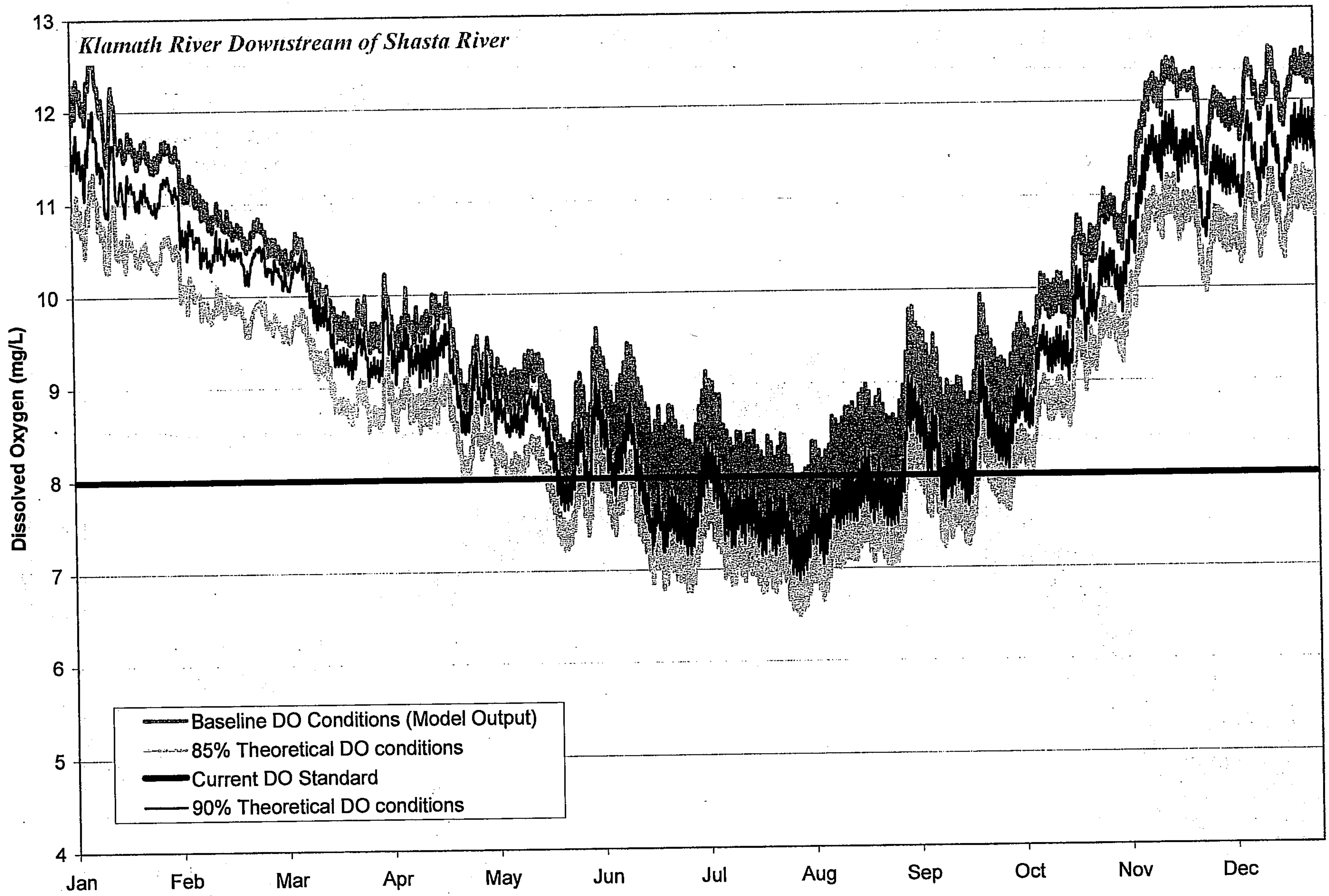
Baseline DO Conditions (Model Output)
85% Theoretical DO conditions
Current DO Standard
90% Theoretical DO conditions



Klamath River Downstream of Shasta River
Dissolved Oxygen (mg/L)
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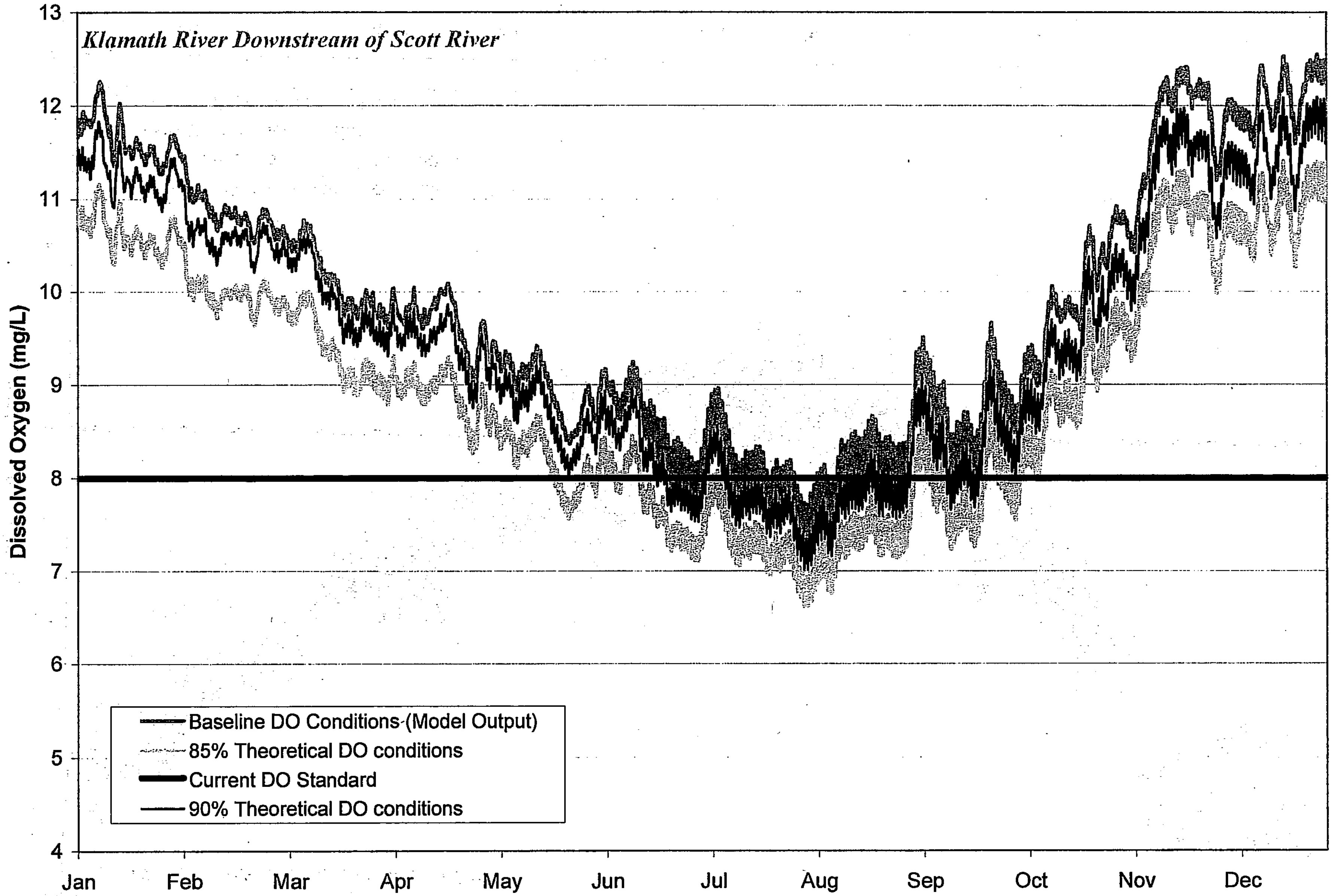
Baseline DO Conditions (Model Output)
85% Theoretical DO conditions
Current DO Standard
90% Theoretical DO conditions


Klamath River Downstream of Scott River
Dissolved Oxygen (mg/L)
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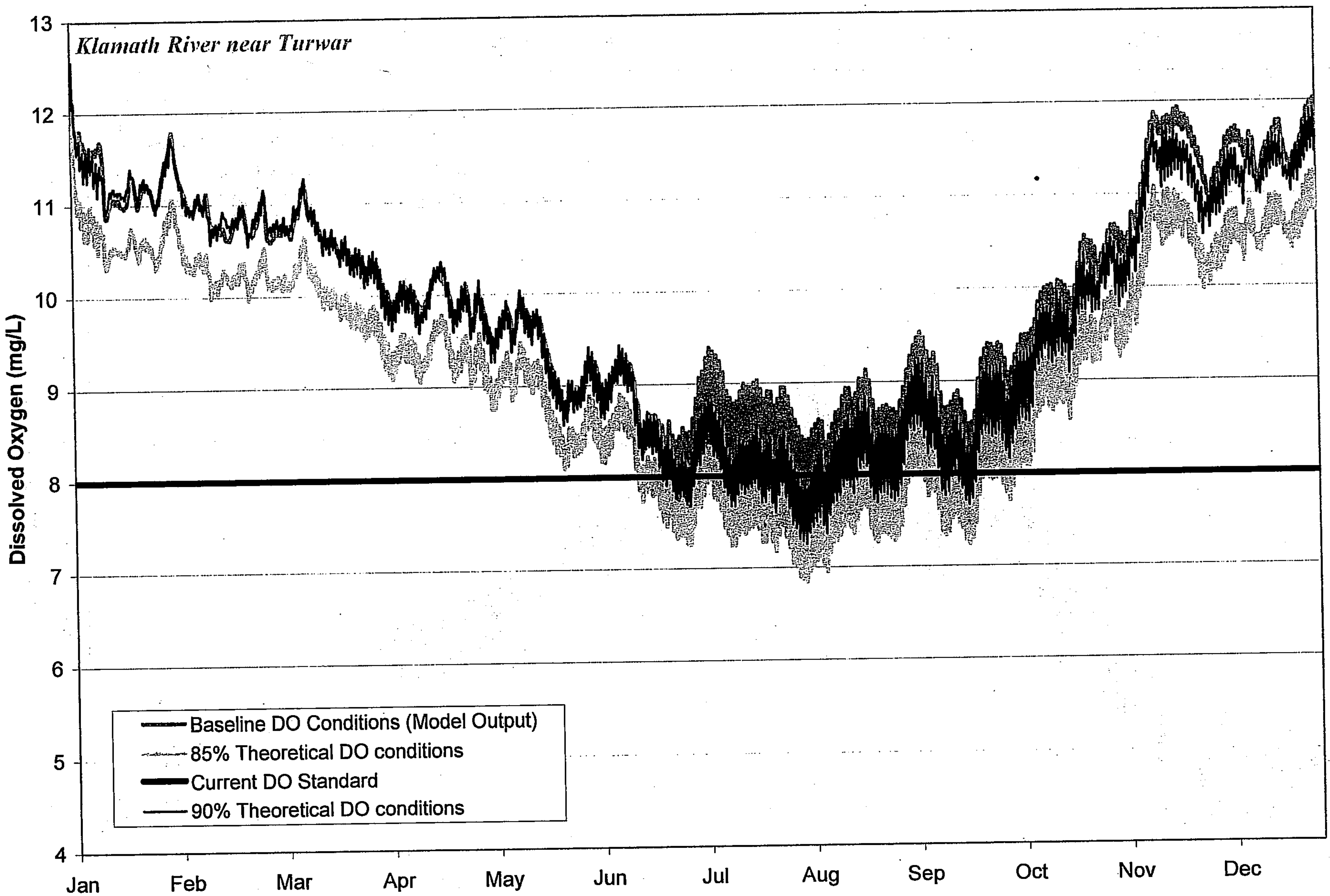
Baseline DO Conditions (Model Output)
85% Theoretical DO conditions
Current DO Standard
90% Theoretical DO conditions


Klamath River near Turwar
Dissolved Oxygen (mg/L)
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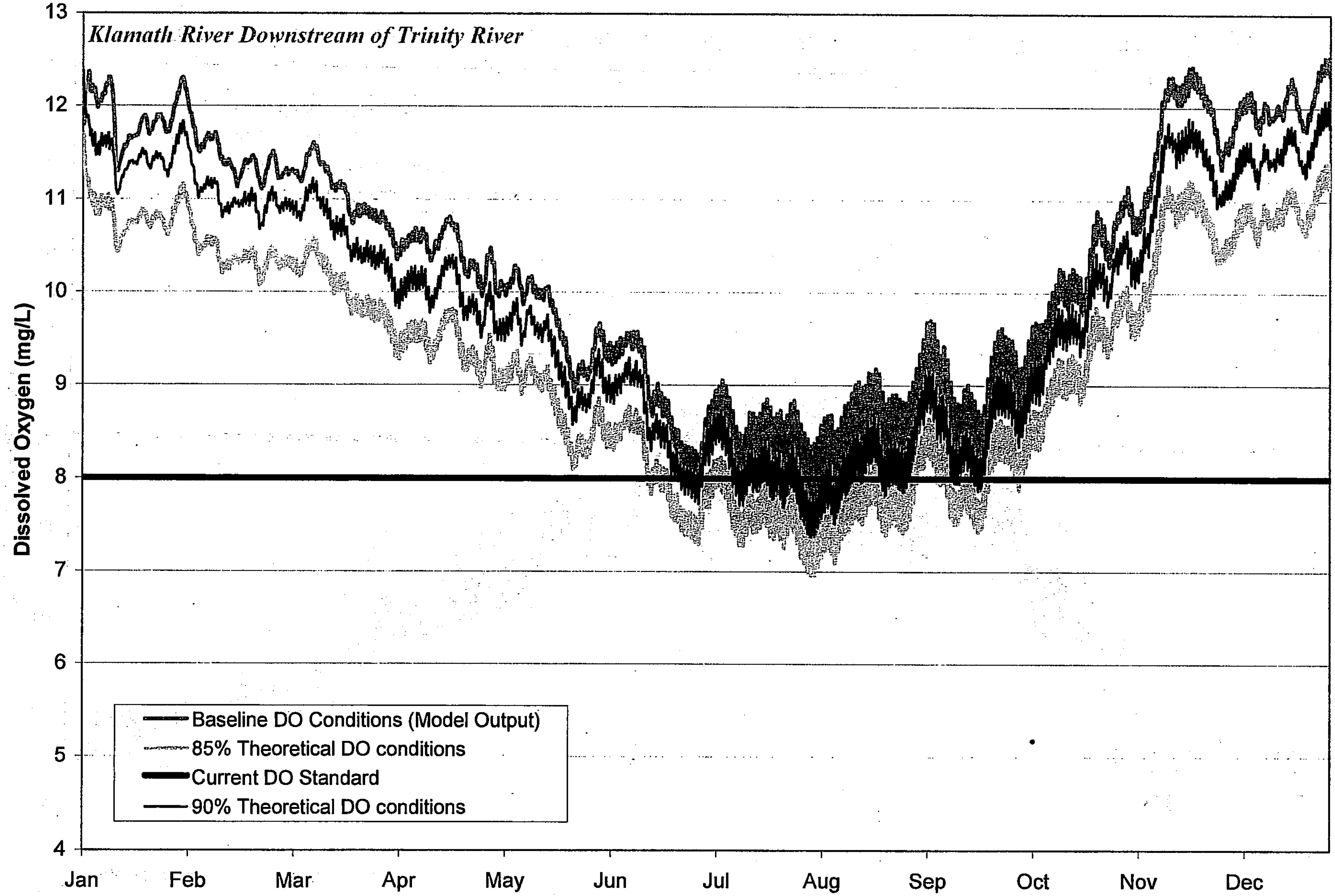
Baseline DO Conditions (Model Output)
85% Theoretical DO conditions
Current DO Standard
90% Theoretical DO conditions


Klamath River Downstream of Trinity River
Dissolved Oxygen (mg/L)
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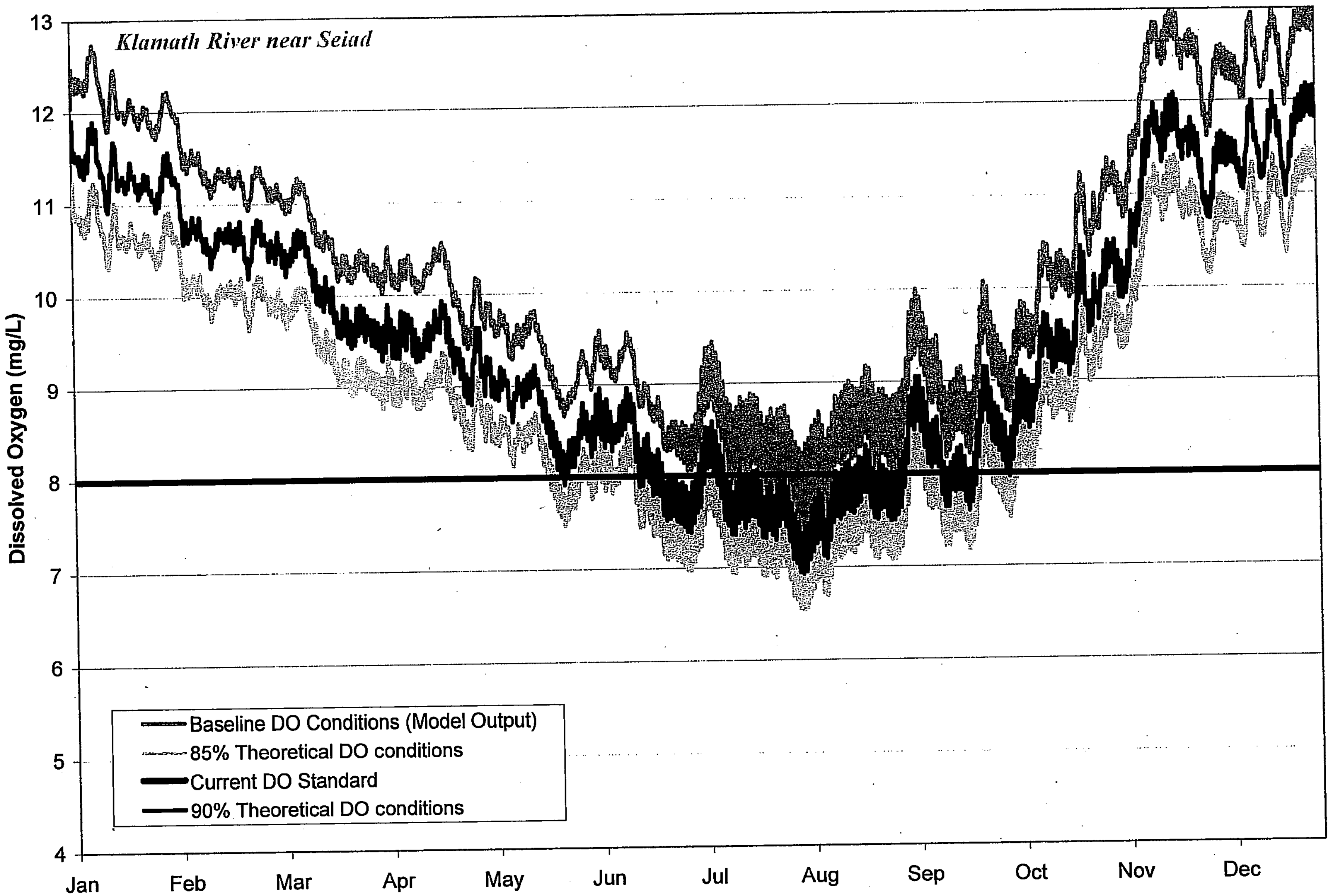
Baseline DO Conditions (Model Output)
85% Theoretical DO conditions
Current DO Standard
90% Theoretical DO conditions


Klamath River near Seiad
Dissolved Oxygen (mg/L)
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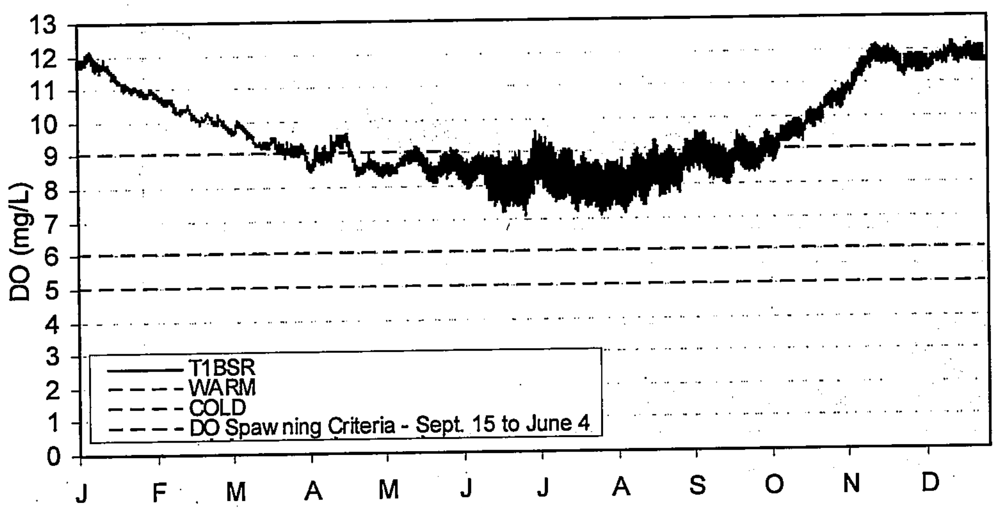
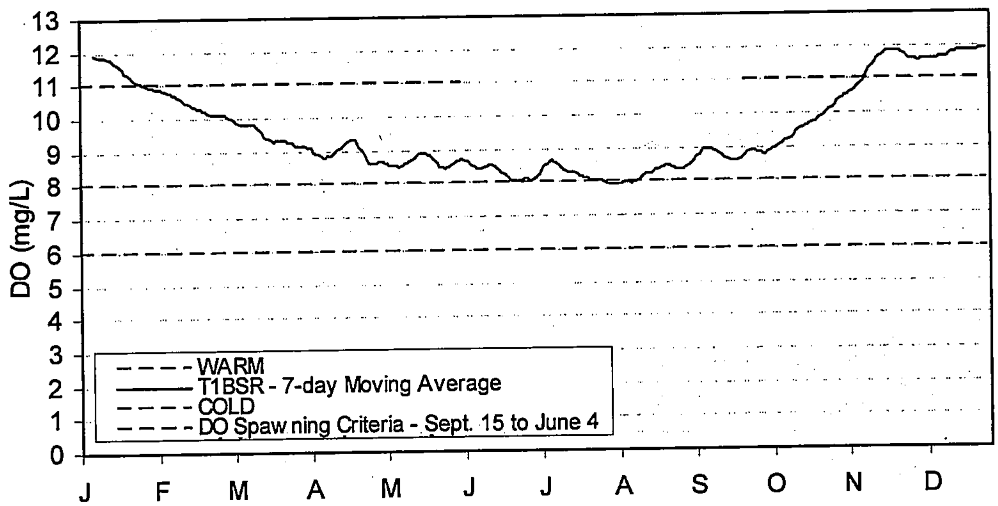
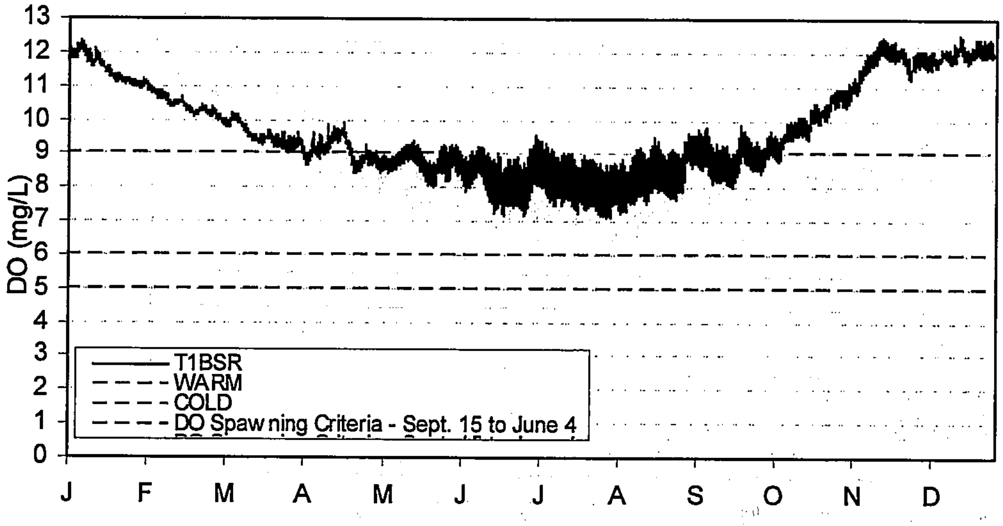
Baseline DO Conditions (Model Output)
85% Theoretical DO conditions
Current DO Standard
90% Theoretical DO conditions

STATELINE – T1BSR





COPCO – T1BSR



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DO (mg/L)
T1BSR
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COLD
DO Spawning Criteria - Sept. 15 to June 4
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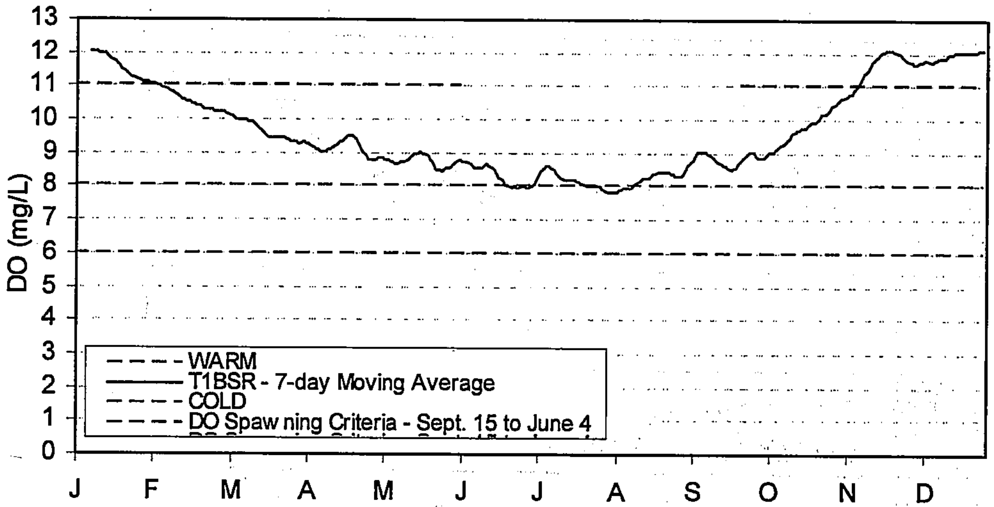

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DO (mg/L)
WARM
T1BSR - 7-day Moving Average
COLD
DO Spawning Criteria - Sept. 15 to June 4
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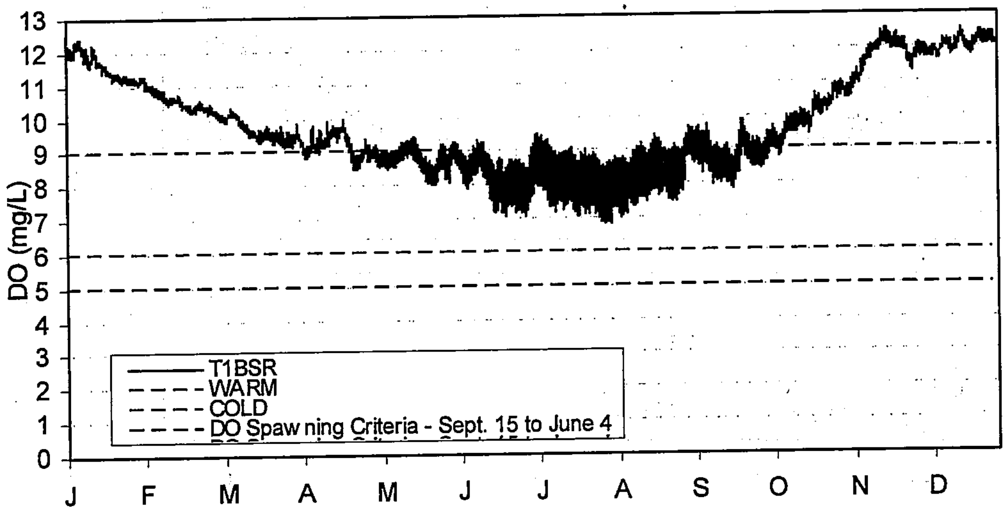
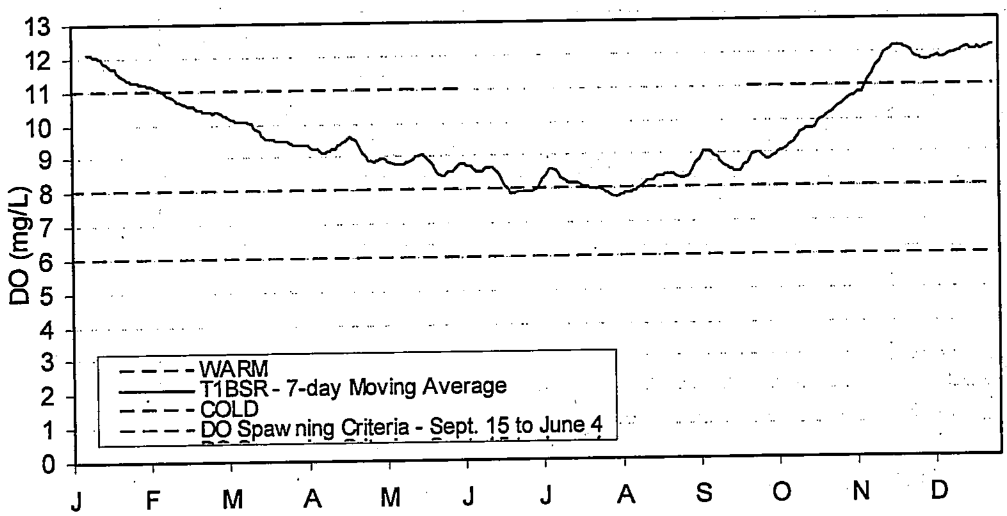
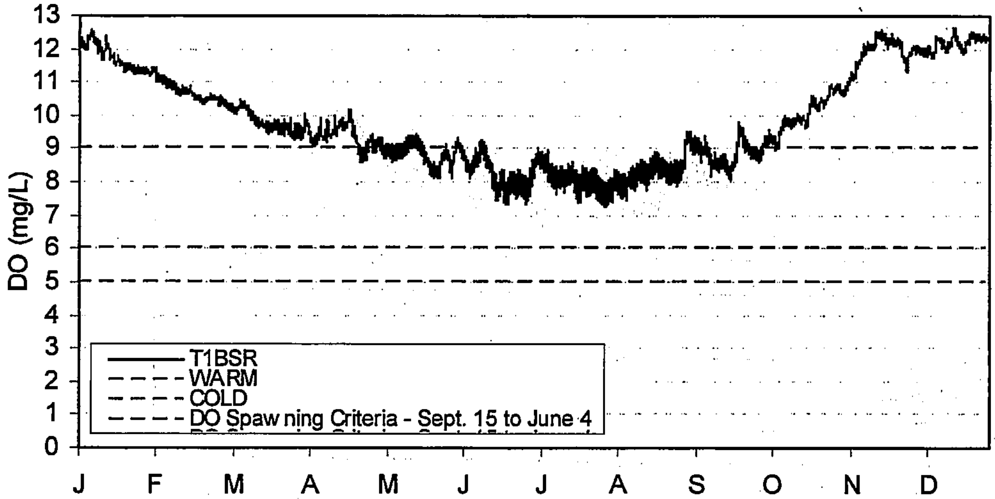
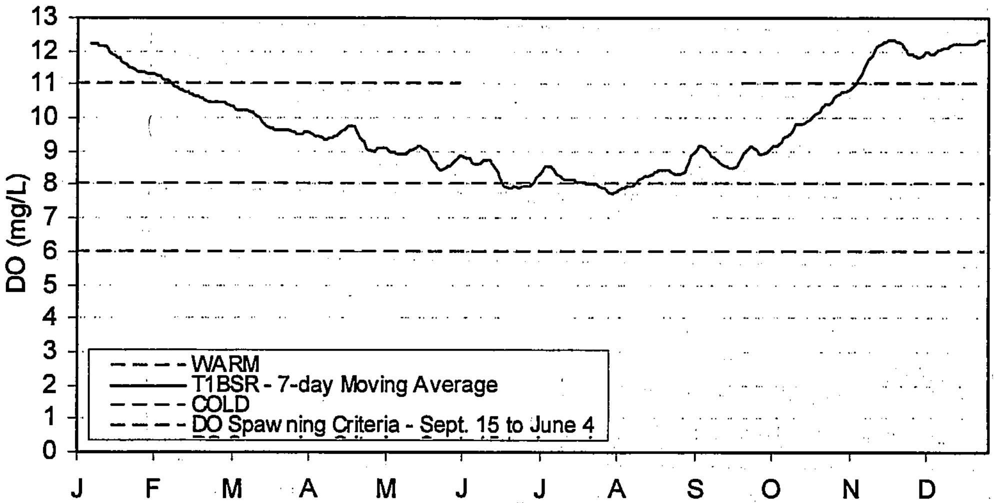
IRON GATE – T1BSR



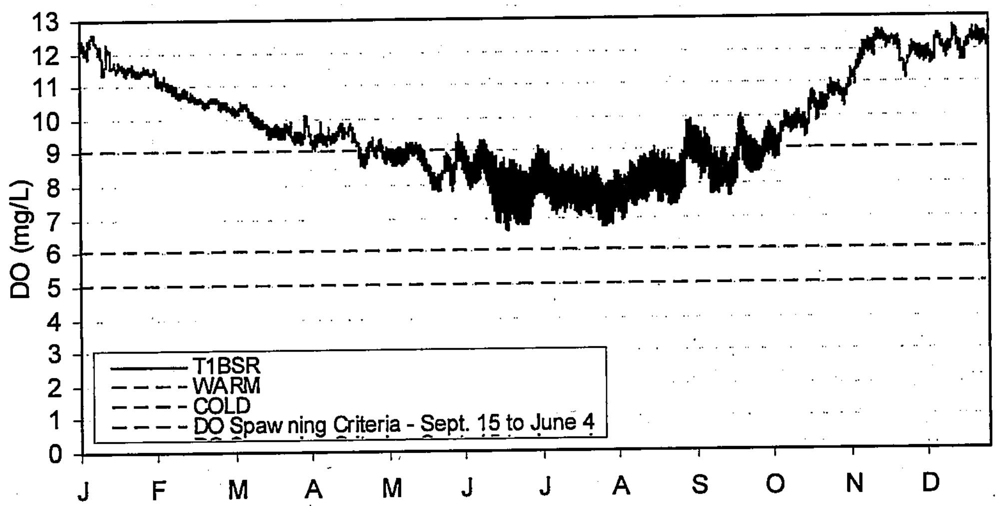


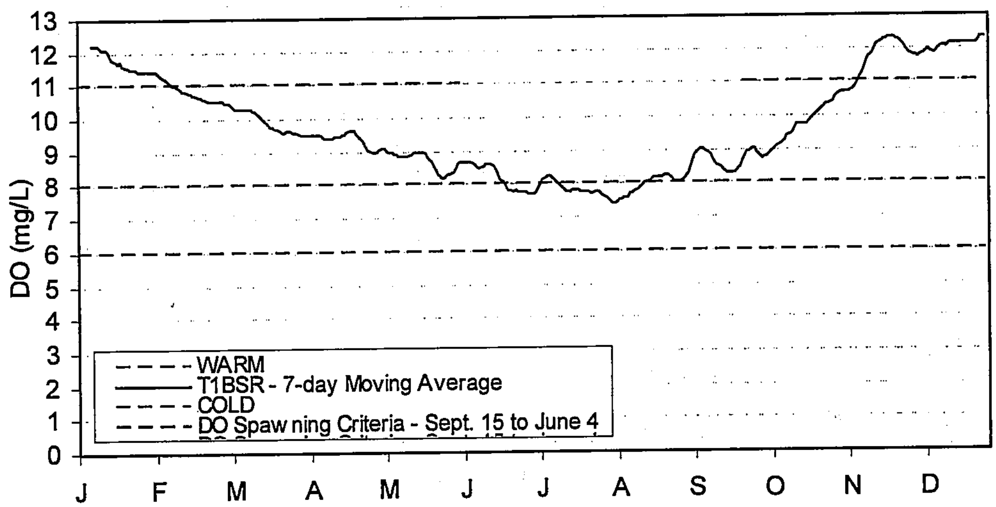
DOWNSTREAM IRON GATE – T1BSR



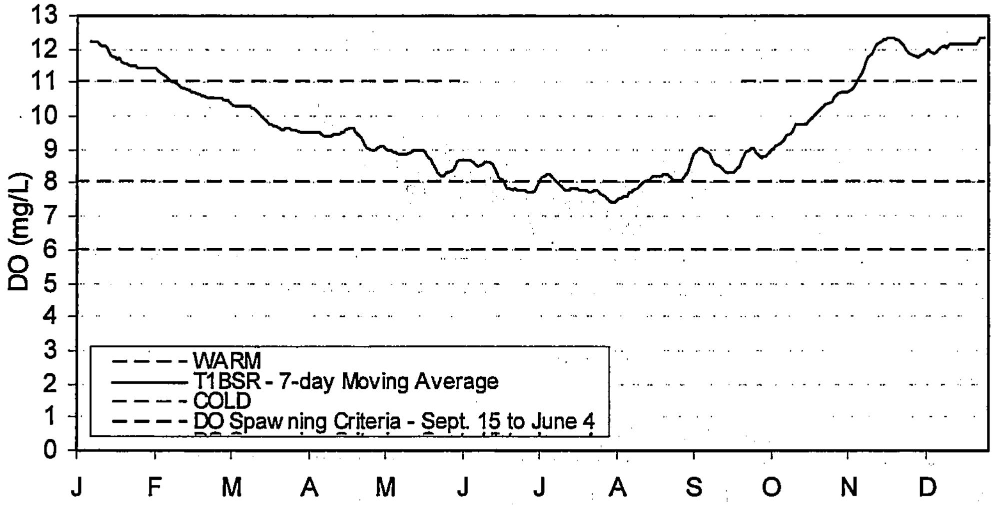


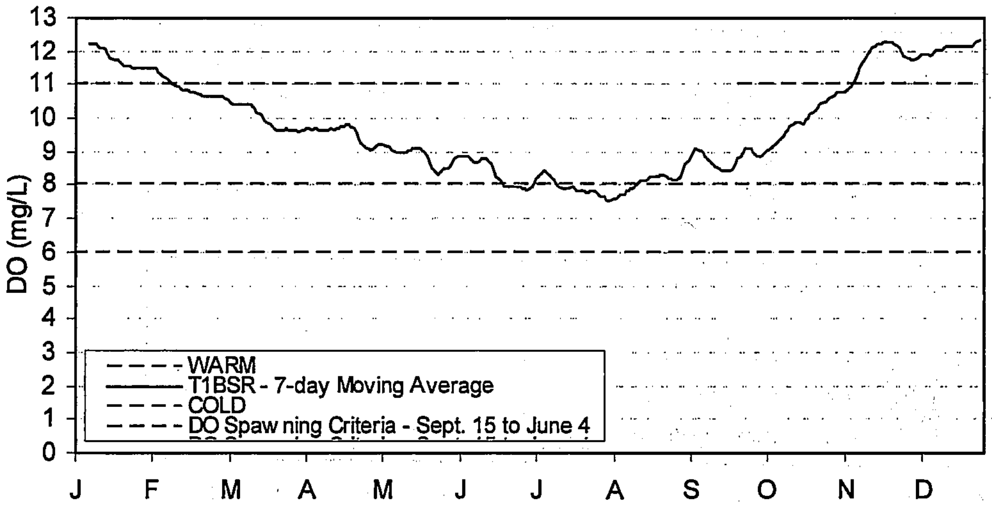
UPSTREAM SHASTA – T1BSR



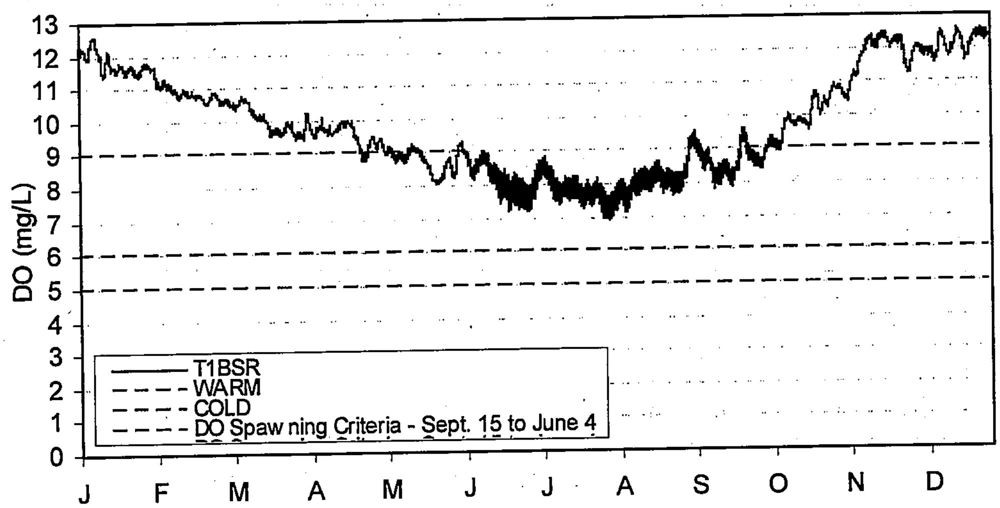


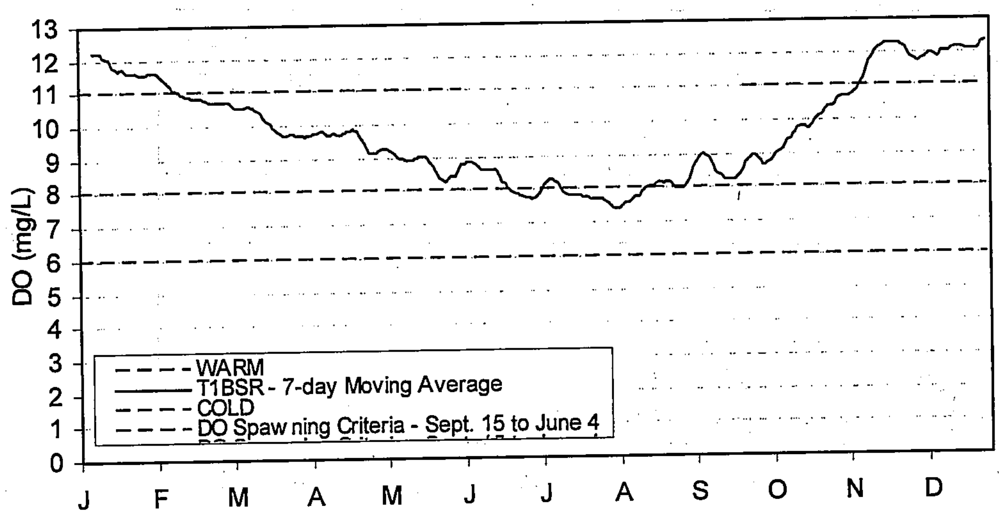
DOWNSTREAM SHASTA – T1BSR



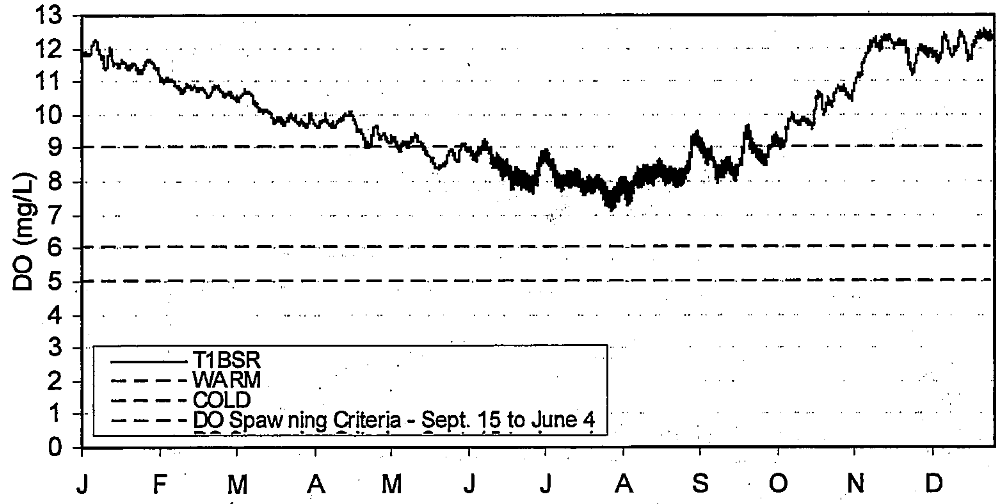


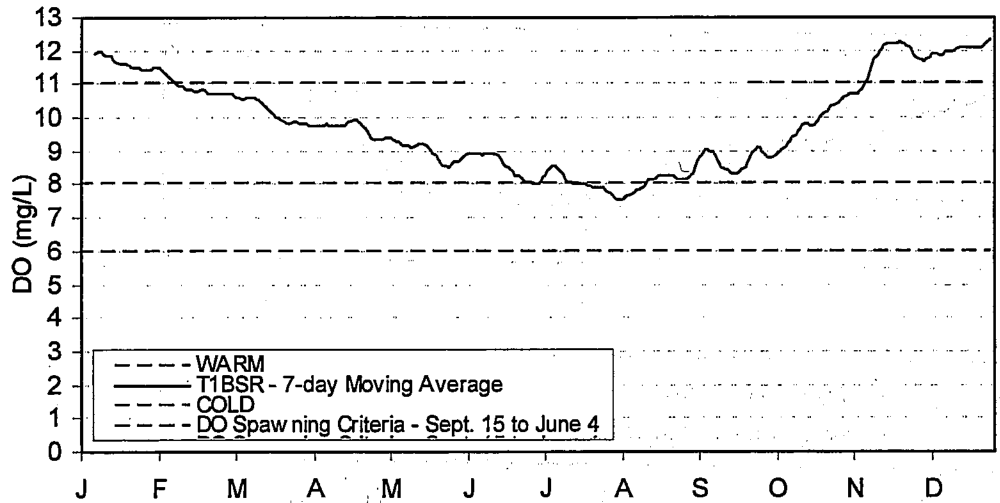
UPSTREAM SCOTT – T1BSR



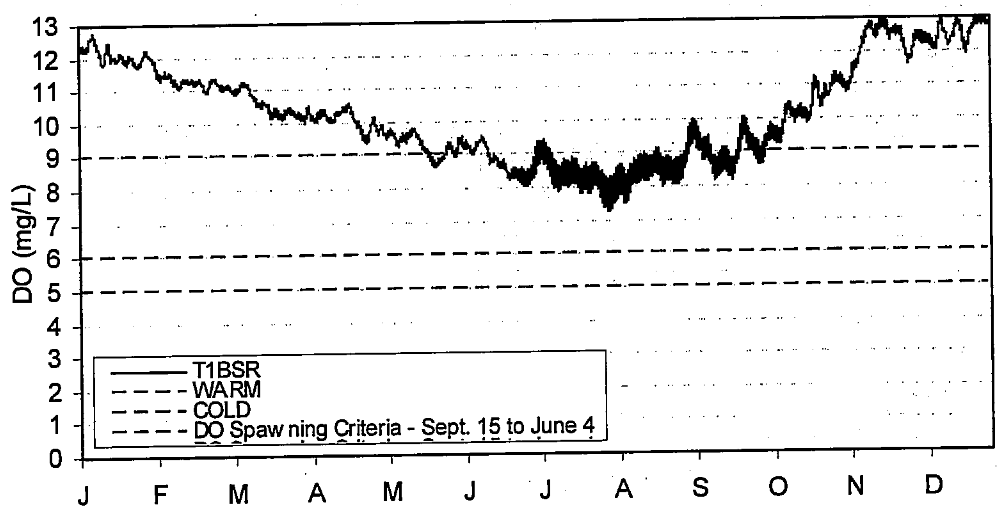


DOWNSTREAM SCOTT – T1BSR





SEIAD – T1BSR



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DO (mg/L)
T1BSR
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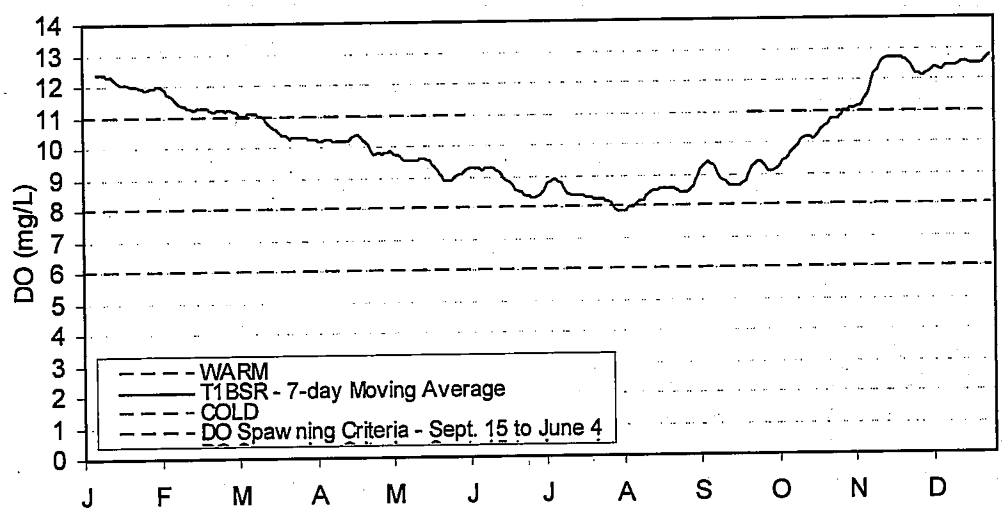

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DO (mg/L)
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T1BSR - 7-day Moving Average
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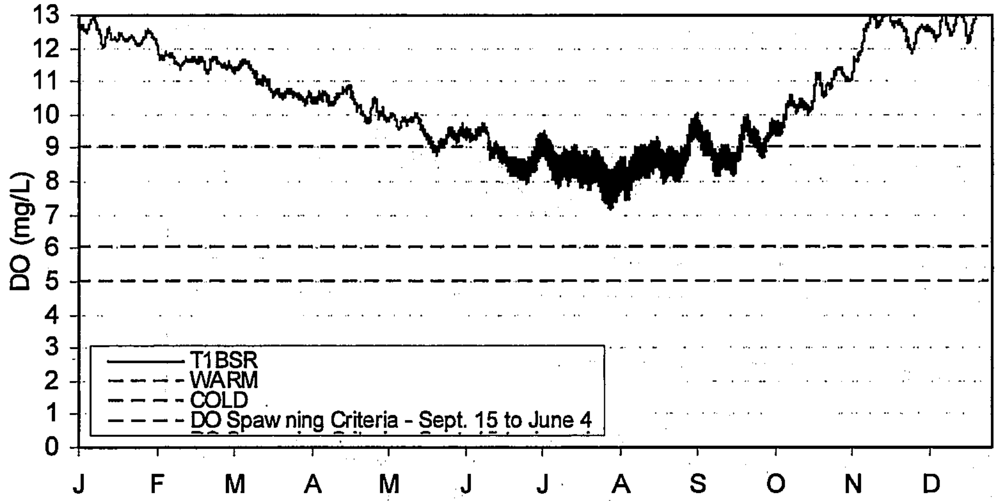
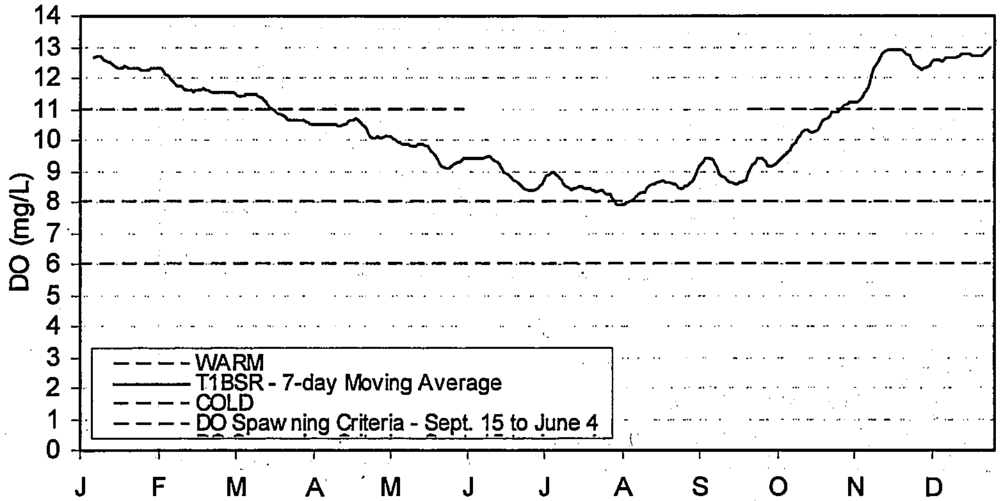
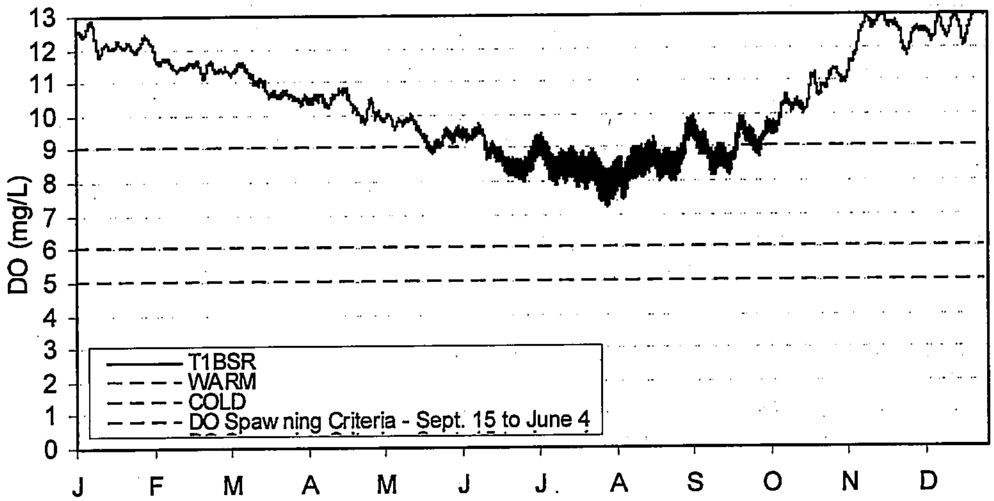
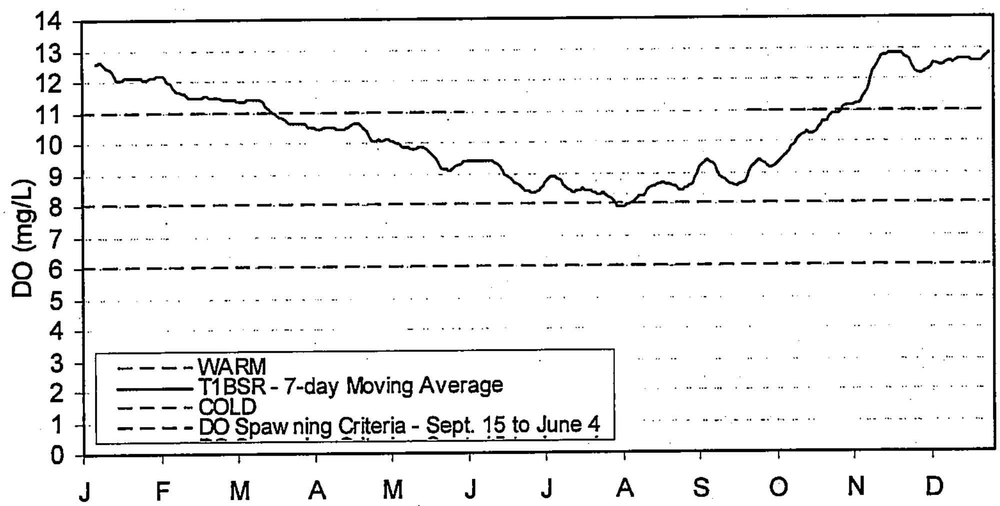
UPSTREAM INDIAN – T1BSR



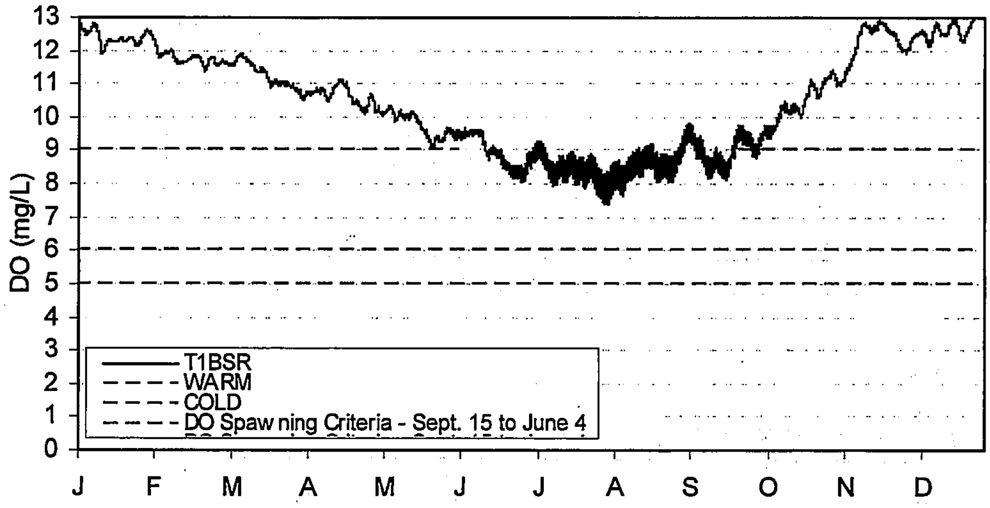


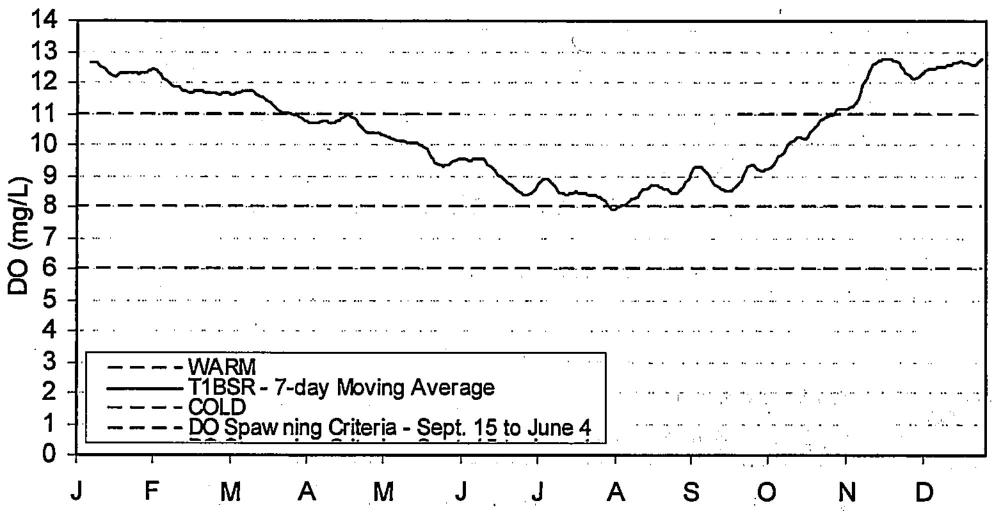
DOWNSTREAM INDIAN – T1BSR



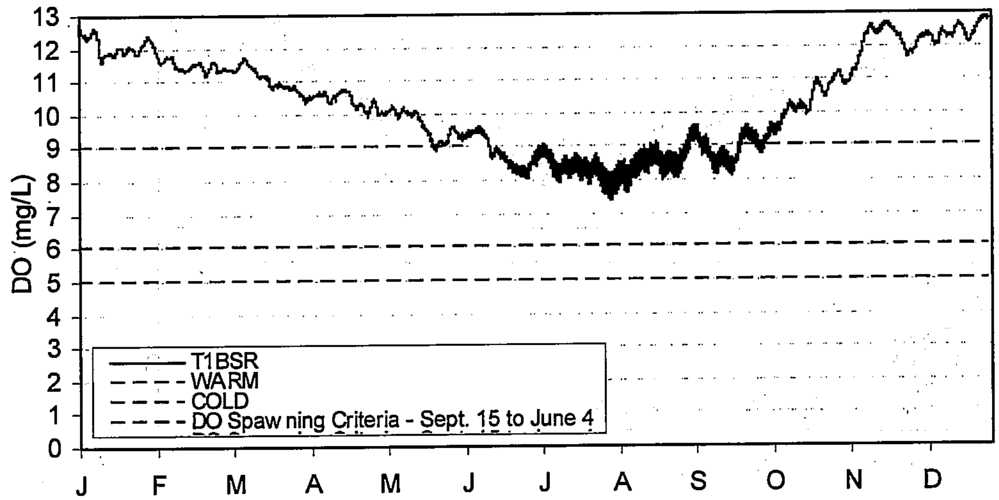


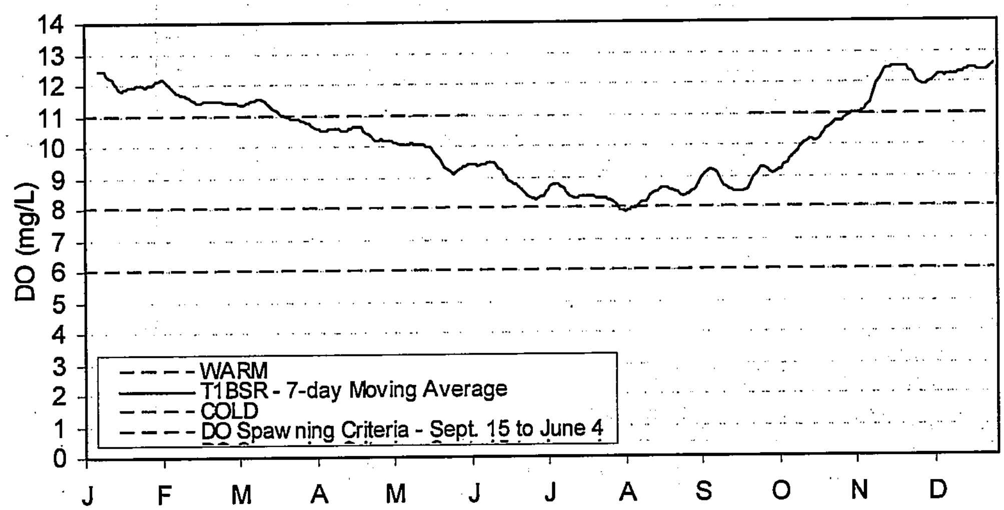
UPSTREAM SALMON – T1BSR



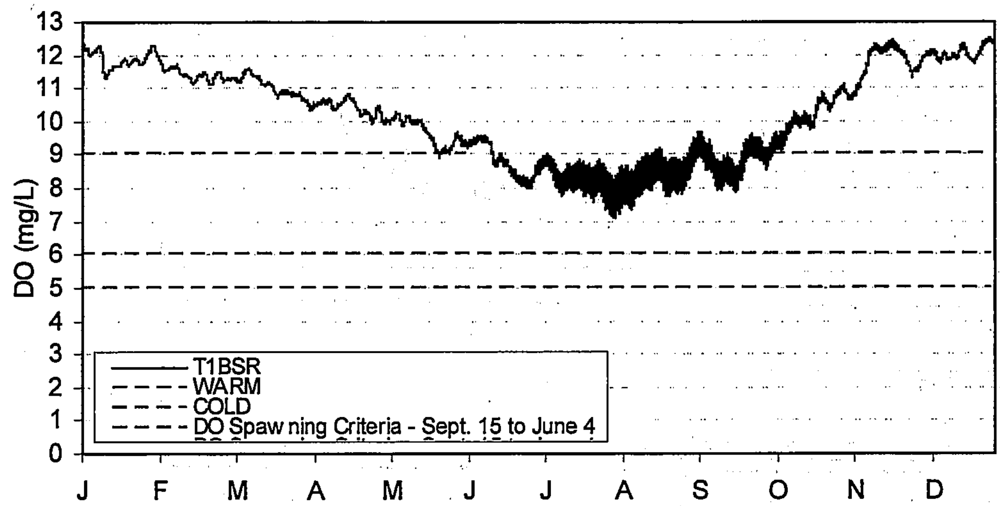


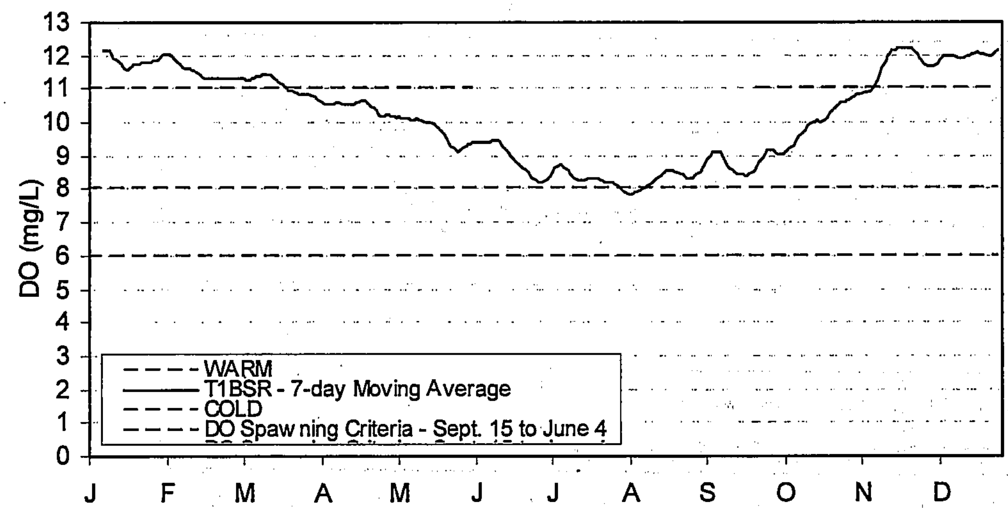
DOWNSTREAM SALMON – T1BSR





UPSTREAM TRINITY – T1BSR





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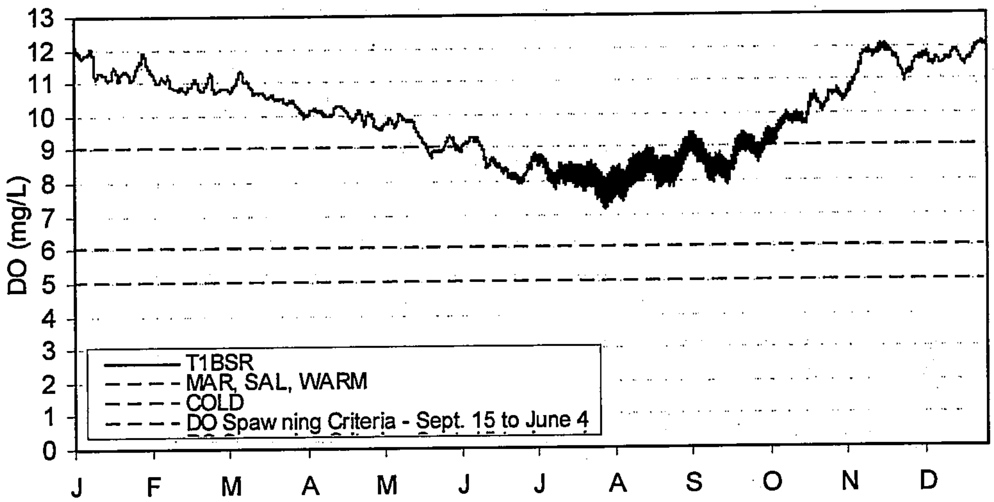

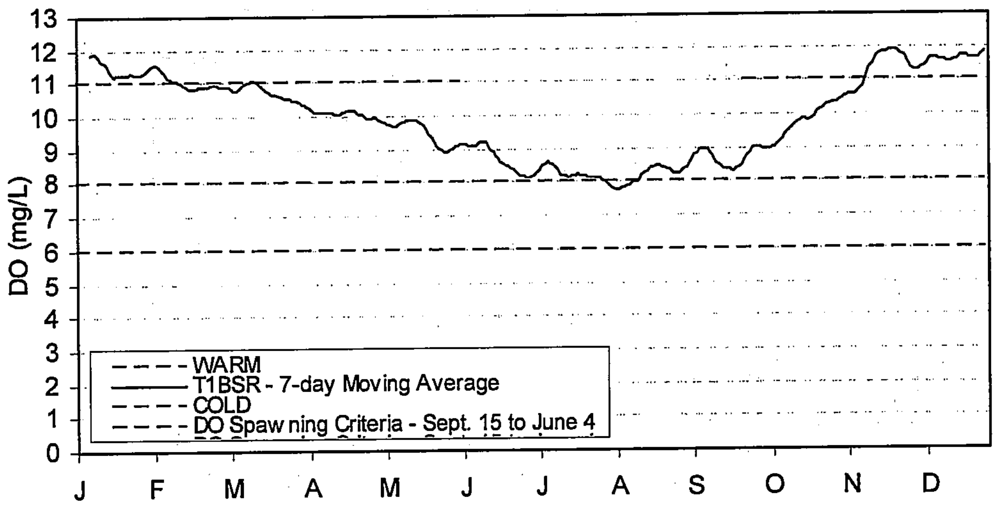

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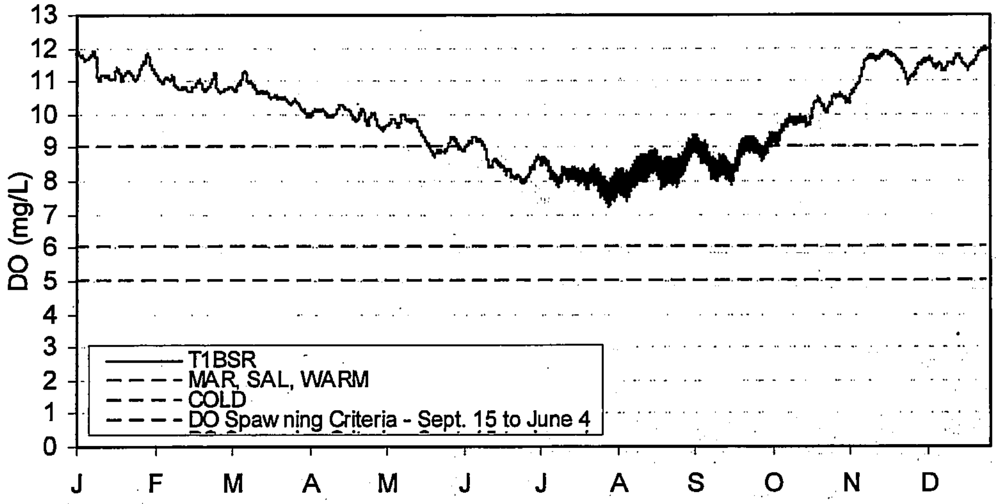
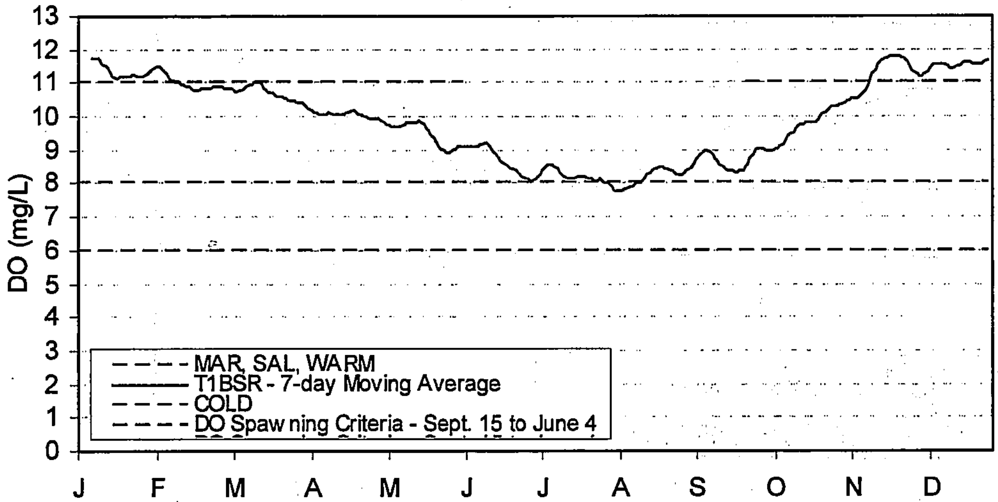
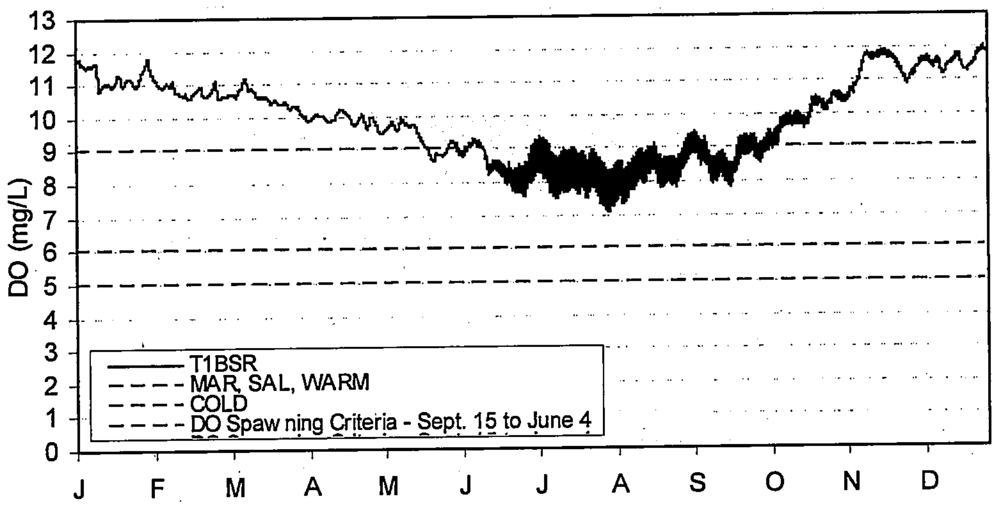
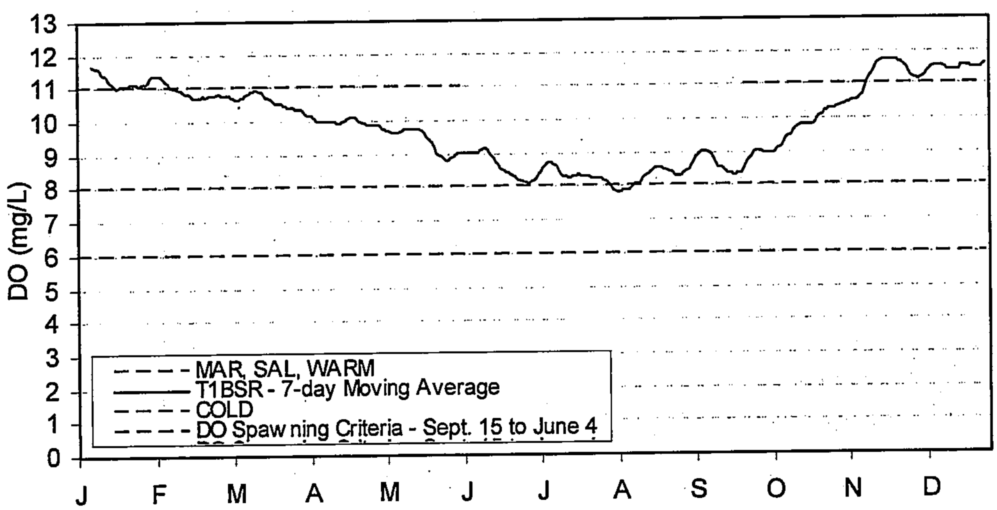


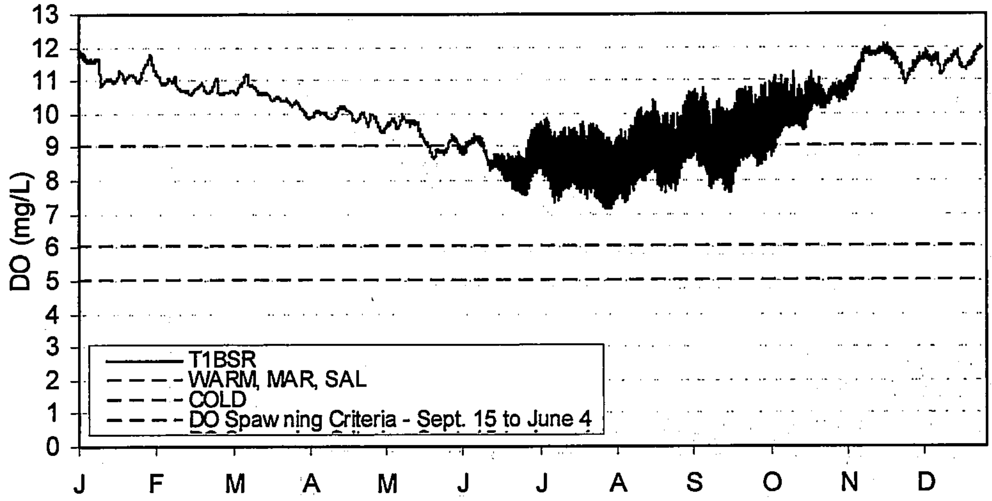


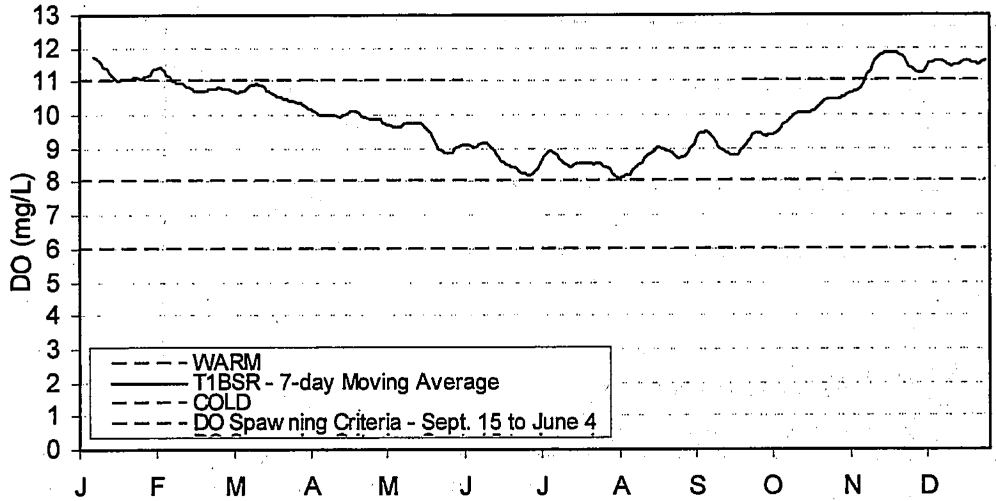
TURWAR – T1BSR



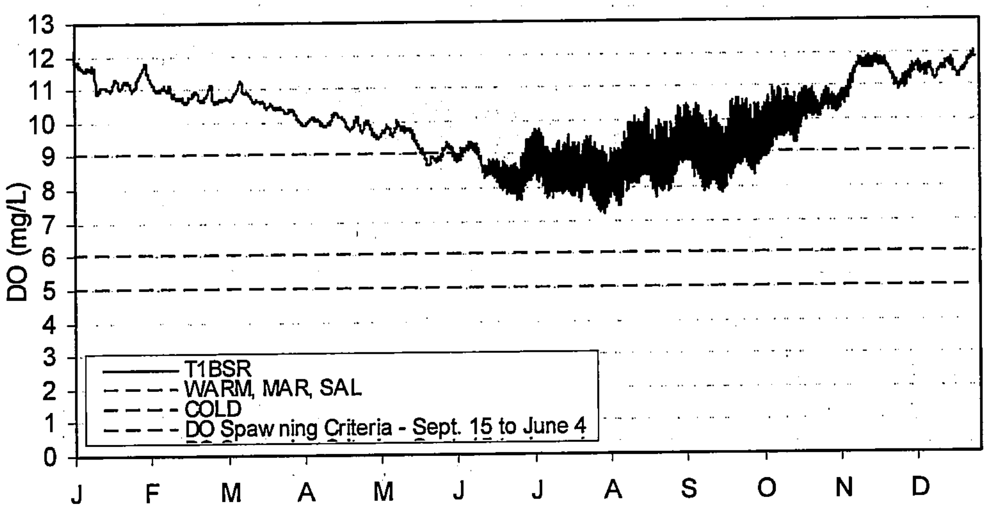


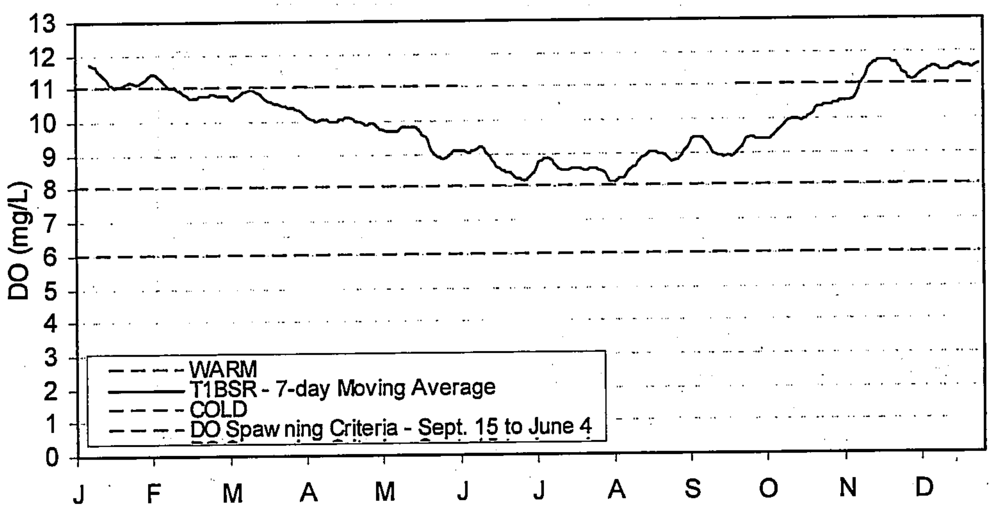
UPPER ESTUARY – T1BSR



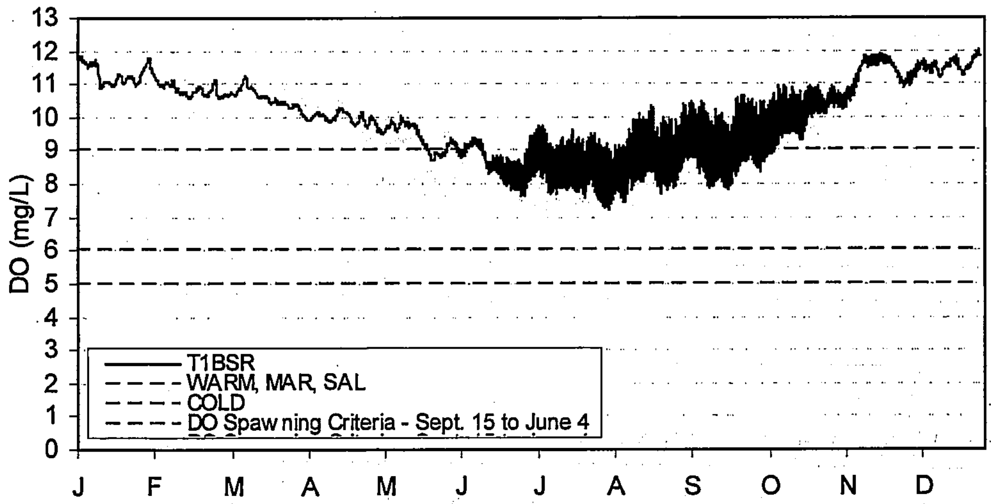


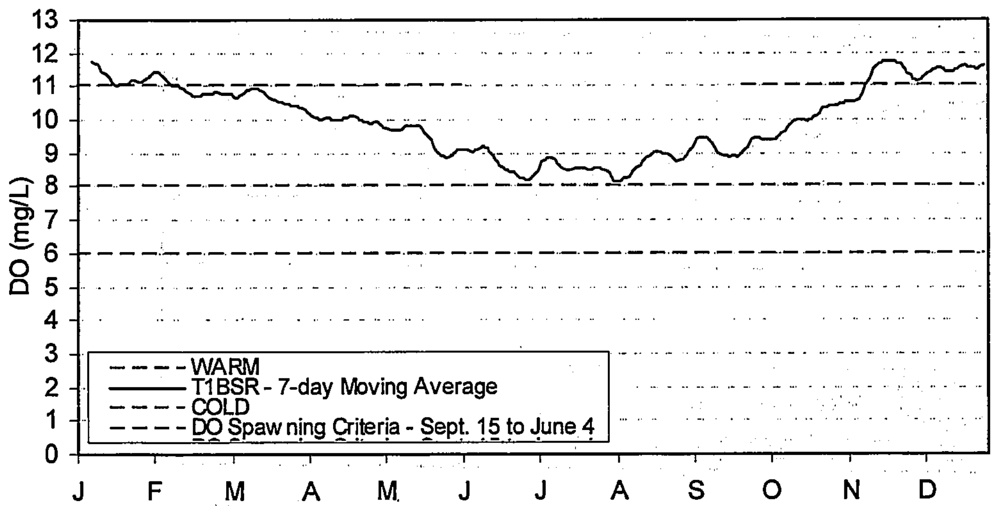
MIDDLE ESTUARY – TOP – T1BSR



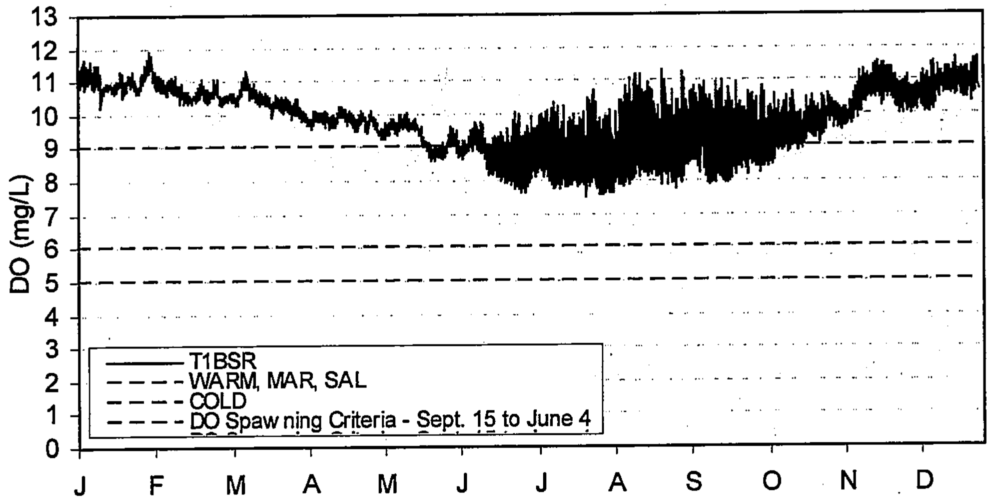


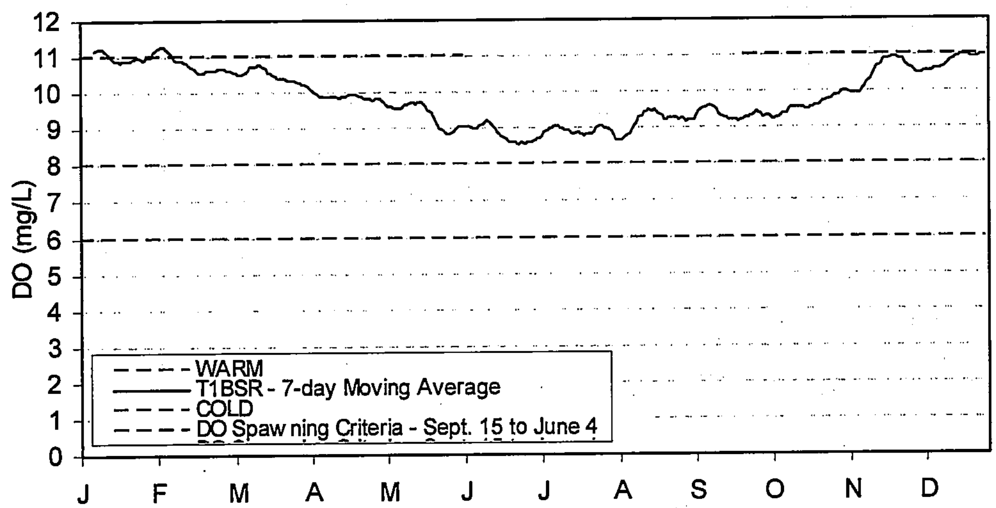
MIDDLE ESTUARY – BOTTOM – T1BSR



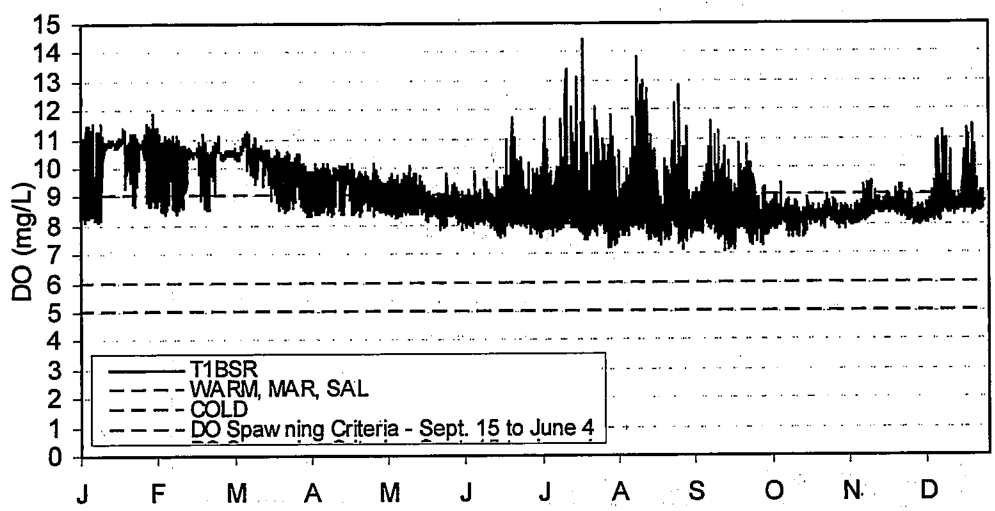


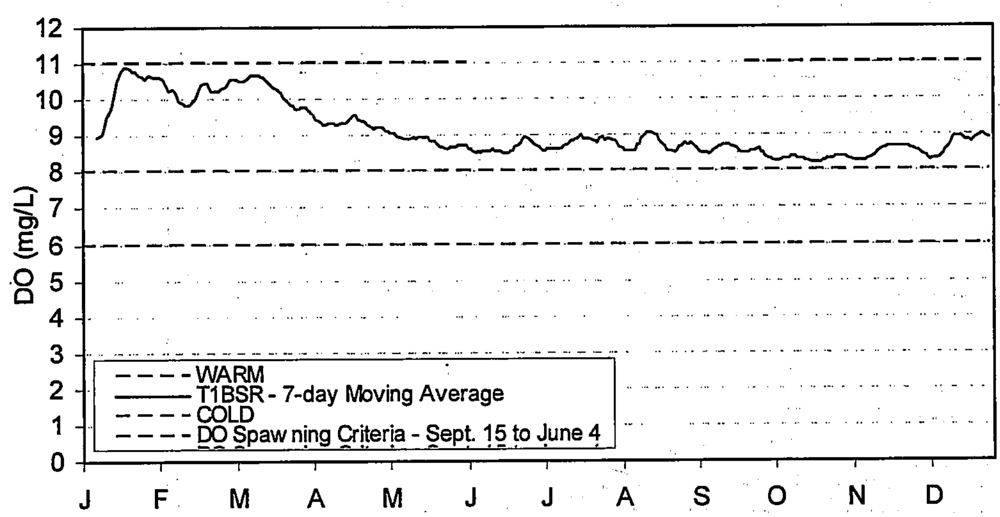
LOWER ESTUARY – TOP – T1BSR





LOWER ESTUARY – BOTTOM – T1BSR





Appendix F

Response to Peer Review Comments on the Staff Report for the Revision of Dissolved Oxygen Water Quality Objectives Peer Review Draft

Response to Peer Review Comments
On the
Staff Report for the Revision of
Dissolved Oxygen Water Quality Objectives,
Peer Review Draft,
dated March 2009

A peer review draft of the Staff Report for the Revision of Dissolved Oxygen Water Quality Objectives, dated March 2009, was submitted in April 2009 to two peer reviewers selected by the State Water Resources Control Board from the University of Washington. The two peer reviewers are Dr. Daniel E. Schindler, Professor of Aquatic and Fisheries Science and Michael T. Brett, Professor of Civil and Environmental Engineering. Below are the comments submitted by each reviewer with an associated response provided by Regional Water Quality Control Board staff.

Daniel E. Schindler, Ph.D
Professor, School of Aquatic and Fishery Sciences
University of Washington

Schindler Comment #1: Overall, I was extremely impressed with the quality and thoroughness of the Staff Report. Establishing oxygen standards to protect fish and other wildlife is far from a simple task and the Staff Report dealt with nearly every possible complication that I could see.
Response #1: Thank you.

Schindler Comment #2: I believe that the proposed revisions are based on the best scientific information in hand. In particular, prioritizing life cycle objectives over background objectives will provide stronger and more justifiable protection for many fish species.
Response #2: The State of California requires a peer review of any proposed rule or regulation that is based on science. Regional Water Board staff appreciates your focus on the specific questions related to the scientific validity of the proposed Basin Plan Amendment and are gratified that you find them satisfactory. Regional Water Board staff agrees that prioritizing life cycle objectives over background objectives will provide stronger and more justifiable protection for many fish species.

Schindler Comment #3: Improved monitoring technologies also enable expansion of oxygen objectives to include weekly average limits. This will provide better protection to organisms from chronic low oxygen concentrations that may only become problematic over longer time periods.
Response #3: Regional Water Board staff agrees.

Schindler Comment #4: The Staff Report represents a very strong synthesis of the state of knowledge concerning stream oxygen dynamics and the requirements of stream

dwelling fishes.
Response #4: Thank you.

Schindler Comment #5: I feel compelled to say that developing an intricate set of objectives is only a worthwhile enterprise if the appropriate research and implementation funding are provided to put them into action. One important aspect of this will be in more intensive data management demands. Moving to a more spatially and temporally explicit monitoring scheme will produce orders of magnitude more data than the old monitoring methods based on grab samples and titrations. To ensure that these new data streams are useful for management, adequate additional funding must likely be directed towards updating the data management systems as well.
Response #5: Regional Board staff share your concern and orientation with respect to monitoring and data management. The State of California implements the State Wide Ambient Monitoring Program, or SWAMP. The program is designed and coordinated at the state office in Sacramento but implemented within each region by Regional Water Board staff. SWAMP is designed to accept, process, and manage continuous DO data, as well as grab samples and titrations. The most dramatic change to monitoring and data management to result from adoption of the proposed DO objectives will be for individual waste discharge permit holders. Waste Discharge Requirements (WDRs) currently require only grab sampling of ambient water quality for DO. But, the adoption of the proposed DO Basin Plan Amendment (BPA) will necessitate that when WDRs come up for renewal, the associated monitoring requirements be updated to include continuous monitoring of DO instead. As you mention, this will result in additional monitoring and data management costs. But, the costs will be spread out among individual dischargers rather than borne by a single entity. Alternatively, Regional Water Board staff is exploring the possibility that dischargers could conduct a study of the diel fluctuation in DO at their particular sampling locations to determine the shape and seasonal duration of the diel curve. With this information, grab samples and titrations could continue to be appropriate, then knowing what part of the diel cycle the grab sample represents.

Schindler Comment #6: The summary of oxygen requirements of all the major fish species in this region of California was strong and thoroughly justified the focus of developing oxygen criteria that protect salmonids. All other species in this region can reasonably be considered less sensitive to low oxygen conditions compared to salmonids. So, although the focus on salmonids is clearly a bias, it is a scientifically justified bias.
Response #6: Thank you.

Schindler Comment #7: The depression of intragravel oxygen concentrations relative to overlying water is expected to vary widely among streams and reaches depending on factors such as gravel porosity, sediment-based oxygen consumption, stream gradient, sediment organic matter content, and temperature. Thus applying a <u>constant</u> correction factor to account for reduced intragravel oxygen concentrations compared to the

overlying stream is certainly a simplifying assumption that is not well substantiated...Although applying a correction factor of 3 mg/L to overlying water concentrations to ensure that eggs and alevins receive adequate oxygen concentrations for development will provide strong protection, this constant correction factor does not seem to be exceptionally well-supported from the scientific literature. I would not say that this correction factor is "over-protective" but it might be unnecessary and in some cases unattainable given the hydrologic, biological, and thermal conditions of streams...It might be worth investing in the science to determine how much intragravel oxygen concentrations deviate from overlying water sources as a function of a variety of physical, chemical, and biological features of streams...I do believe that an 11 mg/L objective will be difficult to achieve under natural conditions in many streams.

Response #7: Staff believes that the water column spawning requirements for salmonids is one of the weak elements of the USEPA's guidance on the development of water quality criteria for DO. As such, we specifically asked for peer review of this element of our proposed objectives.

Staff shares your concern that an 11 mg/L objective is unattainable under natural conditions in many streams. In fact, the water quality model developed for the Klamath River (see Appendix H of the staff report), demonstrates that under natural conditions water quality in the Klamath River mainstem maintains an 11 mg/L 7-day average; but, only from November through February. This is a subset of the period during which actual spawning and incubation occurs for the variety of salmonid species migrating up the Klamath River. One possible explanation is that under natural conditions 11 mg/L is too high an objective for the entire spawning/incubation period.

In combination with the other peer reviewer's comments on this subject, staff has decided to conduct additional research in this area to ensure a more scientifically robust alternate proposal in the future.

Schindler Comment #8: In a cold stream 85% may provide exceptional protection for fish. In a warm stream, 85% may not be adequate because of the compounded effects of a decline in overall oxygen concentration in the warmer water and the increased metabolic rates of fishes in warm waters. I think it is safe to say that at temperatures below 20C that the 85% saturation is a reasonable criterion for establishing baseline conditions that are not stressful to fish. (Although this may not achieve the intragravel requirements). The key point is to embrace the fact that there will be wide variation in what constituted "natural" oxygen conditions among streams. An 85% criterion will capture more of the natural variation than will the 90% criterion.

Response #8: For the reasons you state, the proposed 85% saturation DO objective is intended to apply to COLD designated waters, only. This is a point of clarification staff will include in the revised staff report. Nonetheless, it is important to note that some COLD-designated waters periodically reach temperatures in excess of 20C during the summer months.

Elevated temperatures due to anthropogenic activities

Where elevated stream temperatures are the result of anthropogenic activities, the

Regional Board has the ability to pursue temperature controls through permitting and/or enforcement actions, or through the development of a Total Maximum Daily Load (TMDL) for temperature. The temperature water quality objective contained in the Basin Plan provides a strong basis for protecting natural stream temperatures. It reads: "The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses. At no time or place shall the temperature of any COLD water be increased by more than 5F above natural receiving water temperature." Thus, if the summer time temperatures of COLD-designated streams exceed 20C due to anthropogenic activities, the Regional Board can take action to reduce temperature impairments and restore natural temperature conditions for the protection of beneficial uses, including salmonid habitat.

Elevated temperatures due to natural conditions
In locations, such as the Klamath River mainstem, where natural conditions result in periodic temperatures in excess of 20C, staff's working hypothesis is that salmonids must have historically had access to cold water refugia so as to withstand the stress associated with elevated mainstem temperatures. In such systems as these, the Regional Board identifies the restoration and protection of cold water refugia, either within the deep mainstem pools or in cold water tributaries, as a high priority for the protection of temperature-sensitive aquatic species. Regional Board staff will clarify the proposed DO objective to provide better attention to the issue of refugia protection.

85% versus 90% saturation
With these temperature-related tools in place, Regional Board staff believe that 85% saturation reasonably represents the natural range of saturation conditions expected within an unimpaired river system and provides the necessary protection of beneficial uses. Staff further agrees with your conclusion that 85% saturation better captures the range of natural variation than does 90%. A 90% saturation criterion could too often result in the false assumption of impairment in watersheds where DO naturally varies more widely, thereby unnecessarily diverting staff time and resources away from other demonstrable water quality issues. Staff will review existing region wide temperature and DO data to determine if an assessment of saturation can be made in which this hypothesis is tested. Please see responses to the other peer reviewer's comments for further discussion on this topic.

Schindler Comment #9: The Staff Report offers several alternatives for estimating the natural temperature regime of streams. The first of these methods is to use reference streams that are known to not have been impacted to any large extent. It is proposed that headwater streams are most appropriate for this type of comparison because their water source is ground water which has a relatively constant seasonal temperature. Although I agree that headwater streams may have the simplest suit of perturbations to them, I do not necessarily agree that ground water can be assumed to be their ultimate water source. If the reference stream method is used to assess natural temperature regimes of another stream, extra care should be taken to ensure that the reference and the study streams have similar hydrologic properties because it can not be assumed that they will both be dominated by ground water sources and, therefore, have predictable flow and temperature conditions. Although this method may appear the easiest to use, it is critical that appropriate reference streams are chosen to establish "natural" conditions. The other methods suggested are probably more robust.

Response #9: Regional Water Board staff has revised the text to be inclusive of other sources of headwater flows. We agree that care must be taken to ensure the subject and reference streams have comparable hydrologic properties, and have revised the text so that the caveat applies more broadly.

Schindler Comment #10: When using the simple mixing equation to determine reach temperatures, care must be taken to ensure that groundwater is not a large source to the downstream reach. If a reach of interest has a finite set of well-defined inputs, then the simple mixing equation should be adequate for a relatively short (or short residence time) downstream reach. Of course, this method only works for establishing "natural" conditions if all the upstream tributaries are also in a "natural" condition.

Response #10: Regional Water Board staff agrees, and have edited the text to say that this method calculates the resulting temperature immediately downstream of the confluence.

Schindler Comment #11: I believe that the computer models suggested as the more complicated way to establish "natural" temperature regimes are the most appropriate way to establish baselines. Staff should compare model predictions to observed temperature regimes in a set of streams of various sizes and geomorphic and hydrologic features that are deemed "natural." If the models capture the key aspects of the seasonal changes in thermal conditions, then this is probably the easiest justified approach to establish natural thermal regimes.

Response #11: Regional Water Board staff agrees that the use of deterministic computer models to estimate natural temperatures is the most appropriate method in many, if not most, cases. Staff expects that models developed and employed to estimate natural stream temperatures for the purpose of establishing compliant DO levels will be appropriately calibrated and validated. While we hesitate to characterize these exercises as easy, we also recognize that in many cases the use of deterministic computer models may be the only defensible method to estimate natural stream temperatures.

Schindler Comment #12: The Staff Report suggests three steps to use in order to determine whether "natural" conditions prevent the attainment of life cycle objectives. Recognition of this fact demonstrate the thoroughness of the report as it will likely be common that near pristine streams may often not meet life cycle DO requirements because of a suite of factors such as naturally high levels of nutrients and organic matter, or due to low flow regimes.

Response #12: Thank you.

Schindler Comment #13: The first proposed step is to use continuous monitoring to establish that non-compliance is an issue. Clearly this step will require careful Quality Assurance/Quality Control protocols (something that actually was not discussed much at all in the Staff Report) to ensure that data sondes are not fouled and properly calibrated.

Response #13: The Regional Water Board implements a standard QA/QC program for deployment of the data sondes and retrieval of the data. Any data collected in this manner by WDR permit holders is also required to adhere to the standard, established QA/QC protocols. Data collected by other entities not under the control or guidance of the Regional Water Board will only be used in analysis if the QA/QC protocols are implemented and the data is demonstrated to be sound. The revised staff report will be updated to include this clarification.

Schindler Comment #14: The second step is to produce a conceptual model that specifies all of the anthropogenic and natural conditions that control oxygen conditions in a specific site. This model, as proposed, qualitatively lays out a range of potential drivers of local oxygen conditions. This seems like a logical step in this assessment.

Response #14: Thank you. Regional Board staff also believes this is a logical step in the assessment. As described in the Staff Report, USEPA has produced a generic DO conceptual model which can be used as a template for the development of a site specific model. A link to USEPA's CADDIS web page is included, as well.

The staff report will be updated to clarify the point, however, that the site specific conceptual model requires the development of certain site specific information, including: 1) geology/soils, 2) climate/hydrology, 3) topography, 4) vegetation, 5) DO-related water quality conditions (e.g., DO, temperature, nutrients, sediment), and 6) landuse activities and ownership patterns. This is to ensure that the conceptual model reflects site specific conditions based on a thoughtful assessment of the watershed. This preliminary assessment is also intended to determine what information may already exist which would be helpful to the final step in the analysis.

Schindler Comment #15: The final step is to use a more formal mathematical model (equation) to estimate what the natural oxygen conditions at a site should be given the conceptual model specific in step two. This also seems like a logical step in this process but the specifics of the models to be used are not given so it is difficult to determine whether this final step is achievable. Producing a conceptual model that allows partitioning of the various natural and anthropogenic sources and sinks of oxygen is a relatively straightforward exercise. However, developing a quantitative model that will allow partitioning of anthropogenic from natural sources and sinks is not a trivial task. Although such a model could certainly be developed for any stream in California, these models are generally quite data intensive and will also require considerable technical expertise to develop and use. Without more details on what the model to be will look like, or specifically which data will be used to calibrate and parameterize such models, I really can not comment on whether this procedure will actually achieve what it intends to.

Response #15: There are a limited number of entities that could conceivably seek to demonstrate that the proposed life cycle objectives are unattainable in a given watershed due to the natural conditions of the watershed. Those entities include WDR or National Pollutant Discharge Elimination System (NPDES) permit holders, a watershed group, or

Regional Board/staff. It is important to note, as stated in the staff report, that the quantitative modeling of DO under natural conditions is required only to demonstrate to the satisfaction of the Regional Board's Executive Officer that natural conditions are responsible for excursions of the life cycle objectives. This does not require perfect accuracy. Staff will revise the staff report to clarify the degree of accuracy that is necessary to meet this requirement. Further, staff will identify some of the existing models that could be used to satisfy this requirement.

For WDR or NPDES permit holders, a qualified consultant would be hired to conduct the work. They would identify the available mathematical model(s) appropriate for the watershed in question, given the watershed characteristics, the quality and quantity of existing data, and the ability to collect additional data. The Regional Board, through its Executive Officer, would have final review and approval authority.

A watershed group seeking to redefine the DO objectives for a watershed would similarly have to hire a consultant to assist with the task and face the Regional Board's final review and approval authority. Depending on the nature of the group, it may be eligible to apply for State grant funds to conduct the necessary work. Were State grant funds to be expended to undertake such a project, an additional layer of State oversight would be at play.

Were the Regional Board/staff to undertake the assessment, consultants and/or internal resources, as appropriate, would be employed to conduct the work.

Schindler #16: My final comment pertains to the monitoring plan. Although not stated explicitly, I am assuming that hydrologic flows are monitored simultaneously with temperature and oxygen concentrations. If not, this would be serious oversight. Given the expected changes in hydrologic patterns in response to ongoing climate change, it will be critical to account for changes in hydrology and how these are associated with observed changes in oxygen and temperature. Data describing oxygen and temperature alone will be difficult to interpret as changes could be driven by internal features such as changes in biological productivity, or driven by external features and in particular changes in flow regimes.

Response #16: Thank you for your recommendation. There are several purposes of monitoring associated with the implementation of a given water quality objective. For compliance monitoring, the data necessary include: DO, temperature, salinity, and barometric pressure. From these, we can calculate whether or not DO at a given monitoring station meet the proposed life cycle objectives or the objective of 85% saturation under natural temperatures. We can also assess the degree to which variation in existing temperature from estimates of natural temperatures is responsible for any deviation from the 85% saturation criteria.

As a general principle and when possible, water quality monitoring is conducted in association with USGS gage stations so as to relate flows to water quality data results. The staff report will be revised to clarify this point.

Michael T. Brett
Professor, Department of Civil and Environmental Engineering
University of Washington

Comment #17: It is my general opinion that the current draft guidelines of the North Coast RWQCB dissolved oxygen standard still need some important revisions before they are complete. I would advise basing these guidelines on the strengths of the corresponding Oregon and Washington State guidelines...I don't necessarily advocate directly adopting the standards of either of these states, but the arguments put forth in their guidelines were more thoroughly researched, vetted and explained than those put forth in this document.

Response #17: The guidelines to which you are referring are the 1992-1994 Water Quality Standards Review of Oregon's Dissolved Oxygen standards of the time (Oregon 1995) and Washington State's draft discussion paper and literature summary associated with their evaluation of DO criteria in 2002 (Washington 2002).

<u>1991-1994 Water Quality Standards Review (1995)</u>
The Oregon Department of Environmental Quality convened a Technical Advisory Committee (TAC) and tasked them to review Oregon's Dissolved Oxygen criteria and provide recommendations for improvement. The TAC included Dr. Gary Chapman of USEPA as Chair, Dr. Lawrence Curtis of Oregon State University, Dr. Richard Ewing of the Oregon Department of Fish and Wildlife, Timothy Hall of National Council for Air and Stream Improvement (NCASI), Dr. Robert Hughes a consulting Research Scientist, Kenneth Iceman (P.E.), Dr. Alan Nebeker of USEPA, Ron Rhew of U.S. Fish and Wildlife, and Roger Sherwood of Forest Products Industrial Source.

The TAC drew the following conclusions regarding the DO standards in place at that time:

1. "The "natural" conditions in some streams will cause dissolved oxygen levels to fall below the numerical criteria, especially the conservative 90-95 percent criteria when interpreted as absolute minimums.
2. The currently relaxed criterion of 75 percent of saturation for Eastern Oregon may not be justified based solely on the needs of the aquatic resources.
3. Although scientific data provide the basis for water quality criteria, the data are limited.
4. Saturation criteria may result in inadequate protection at high temperatures and greater than necessary criteria at low temperatures, often inversely related to the needs of the resource. Because of the high level of protection warranted for salmonid spawning, concentration and saturation criteria would be similar for this use.
5. Current criteria do not directly address the intergravel dissolved oxygen concentrations that directly influence the survival of salmonid embryos. Highly sedimented gravels may experience DO losses of more than 6 mg/L.
6. Current criteria recognize that situations will occur where the achievement of dissolved oxygen standards will not be possible due to natural occurring conditions or due to human activities which are beyond regulatory control. In

these cases, the background conditions become the criteria and no further degradation is permitted. Other states, such as Washington, provide an allowance on the order of 0.20 mg/L for further degradation under similar conditions.

7. Application of the minimums alone with inadequate data would allow acute conditions to exist.
8. 10% of the reference sites and 24% of the REMAP sites in the coast range would violate a 90% saturation criterion, even though they meet a no measureable impact to cold-water fish criteria of 8.0 mg/L.

Regional Board staff reviewed Oregon (1995) as part of the research associated with developing its proposal for the North Coast region. Regional Board staff found that Oregon (1995) provided the invaluable insight of numerous talented and respected scientists in the field of water quality protection. For that reason, staff designed the proposed DO objective revisions based, in part, on the recommendations of the Oregon TAC. Below are some of the recommendations of the TAC and the ways in which staff's proposal was designed to address them.

Some of the recommendations of the TAC included:
Recommendation #1: Criteria should be related to the biological resources that are to be protected. Through literature review, staff identified the variety of fish species found within North Coast watersheds and determined their DO tolerances, if known, concluding that DO conditions suitable to protect the life cycle stages of salmonids would also be suitable to protect other fish species. The life cycle requirements of salmonids for DO were then identified through literature review, including review of Oregon (1995), Washington (2002), and USEPA's (1986) guidance on the development of DO criteria. Much of this is summarized in Carter (2005), a staff-prepared and peer reviewed literature survey of the effects of DO on salmonid species by life stage. The resulting proposal includes numeric criteria specifically tailored to the protection of the life stages of salmonid species.

Recommendation #2: There should be greater consistency between the criteria for different river basins. Staff addresses this recommendation by proposing the elimination from Table 3-1 of the Basin Plan the site specific DO objectives assigned to individual waterbodies in the region and establishing life cycle based requirements as the first tier requirements, instead. Second tier requirements are established on a site specific basis only for those waterbodies unable to meet the first tier requirements due to natural conditions.

Recommendation #3: Critical compliance issues related to temperature and dissolved oxygen need to be analyzed. The State needs to manage its aquatic resources much more broadly than by single parameter or by point-source pollution control. Staff addresses this recommendation by fundamentally altering the way in which percent saturation is typically used in the regulatory arena. Percent saturation, as discussed in Oregon (1995) for example, is calculated measuring existing site salinity, site temperature, and site atmospheric pressure. Used in this way, percent saturation "ignores" the effects of anthropogenically elevated temperatures on DO, essentially sanctioning temperature increases. Staff proposes that percent saturation be used as a water quality criterion but, based on estimates of *naturally* occurring stream temperatures. In this way, any increase from natural temperatures is reflected in the DO compliance record.

In addition to DO, the Basin Plan includes related water quality objectives for biostimulatory substances (including nutrients and organic matter), settleable material, sediment, turbidity, pH, and temperature. These parameters are often evaluated in concert with one another, depending on the waterbody and the issues at play. In a related matter, the Basin Plan prohibits the point source discharge of waste to most of the waterbodies within the North Coast region. As such, the water quality protection strategies employed in the North Coast region focus heavily on nonpoint source discharges, including hillslope and riparian zone alteration through timber harvesting activities and others. This is a unique strength of the North Coast region's water quality protection program and differs widely from the programs in place in many other regions and states where point source control remains the highest priority.

Recommendation #4: Concentration criteria should be used rather than percent of saturation for other life stages of cold-water biological resources, with the exception of supersaturation criteria. The criterion for early life stages of cold-water fish could be equally well presented as a percent saturation. Staff addresses this recommendation by proposing the calculation of percent saturation based on an estimate of *natural* receiving water temperatures, thereby better ensuring that the lower DO of the summer months are in the range to which aquatic species are adapted. Staff does not propose a supersaturation criterion, a fact which will be re-evaluated prior to our final recommendation to the Board.

Recommendation #5: Statistical criteria with associated duration period should be used. Staff has proposed the use of statistical criteria with associated duration periods for the protection of spawning and other life stages of cold water species.

Recommendation #6: Statistical criteria should be applied only when adequate data are available. Staff's proposal includes a discussion of the number and type of data required to measure compliance with the proposed objectives. Staff will ensure that the final proposal makes perfectly clear this requirement.

Recommendation #7: The early life stages criteria for salmonid protection should apply during the latter stages of incubation of embryos and fry, until after fry emerge from the gravels. The protective criteria need only apply to areas of salmonid spawning. Staff's proposed criteria are established as recommended.

Recommendation #8: The state should establish intergravel dissolved oxygen criteria for protection of the early life stages of salmonids. For unimpaired watersheds, the expected loss of an average of 3.0 mg/L DO from surface to the gravels provides the method for determining minimum surface-water concentrations. The assumption of a 3.0 mg/L loss between surface and intergravels

may underestimate the loss that occurs in highly impacted spawning areas. Staff has proposed the adoption of water quality objectives designed to protect the intergravel dissolved oxygen requirements of incubating embryos and fry, as described above. The proposed water quality objectives are daily minimum and 7-day moving averages measured in the water column, calculated by adding 3.0 mg/L to the intergravel requirements as described by USEPA (1986) in its guidance. Staff did not distinguish between unimpaired and impaired waterbodies for several reasons.
1, The Basin Plan includes water quality objectives to control settleable matter, sediment, and turbidity, as well as DO.
2. The North Coast Board has a well-developed program designed to identify and control the discharge of excess sediment to waters of the North Coast.
3. A committee of staff and board members has developed as a basin plan amendment, now awaiting Board approval, a region wide prohibition on the discharge of excess sediment to North Coast waterbodies.

It is clear that the DO of the intergravel environment found in heavily sedimented basins could be reduced by more than 3.0 mg/L. Staff's intention is that this issue be addressed through the existing sediment-control program of the Board and the development of the region wide excess sediment discharge prohibition. Of additional concern, however, is the question of whether or not 3.0 mg/L is overly protective under unimpaired conditions. This is of concern because the objectives are designed in two tiers—the first tier based on life cycle requirements and the second tier based on an estimate of background conditions. Staff's proposal is that the second tier requirements only be applied if the first tier requirements can not be met due to natural conditions. If the first tier requirements are set artificially high, then the second tier requirements will apply more broadly than intended. As recommended by the Oregon (1995) TAC, the primary requirements are intended to be designed to specifically address the needs of the biological resources (See Recommendation #1).

Staff's concern about over protectiveness is derived from the fact that modeled estimates of DO under natural conditions in the Klamath River indicate that water column criteria designed to ensure adequate intergravel DO can not be met for more than a couple of months of the spawning and incubation season. It was on this basis that staff asked peer reviewers to consider whether or not 3.0 mg/L might be overly protective and unachievable in some instances.

Staff will reconsider the question of whether or not a distinction should be made in the application of the proposed DO objectives in those watersheds which are sediment impaired versus those that are not.

Recommendation #9: The importance of nutrient and sediment runoff and removal of the riparian canopy as major cause of DO depletion in streams and lakes should be recognized. Please see response to Recommendation # 3 above.

Recommendation #10: The impact of stream flows on temperature changes and therefore on DO should be recognized. The Regional Water Board does not have any direct authority over the control of river flows in north coast streams. Instead, that authority lies with the State Water Board in Sacramento where water rights permits are reviewed and issued. The State Water Board has an obligation to ensure that any of their actions, including water rights actions, are consistent with the Regional Water Board's basin plan, however. Thus, the North Coast Board has developed flow recommendations in individual Total Maximum Daily Loads (TMDLs), such as in the Shasta and the Scott River watersheds, and has included these recommendations in the Basin Plan to inform the actions of the State Water Board. In these two cases, the flow recommendations are for particular stream reaches which produce an abundance of cold water important to the control of temperature conditions downstream.

Simultaneously, the State Water Board has developed a draft North Coast Instream Flow Policy in which it has attempted to determine the flow requirements necessary to provide healthy, productive salmonid habitat in North Coast streams. This policy will guide the State Board in its decisions regarding water allocations in the future and will certainly improve their ability to make decisions protective of salmonid habitat.

Further, the North Coast Regional Board and the San Francisco Bay Regional Board have collaborated on the development of a narrative flow objective which describes the vertical, lateral, and longitudinal hydrological connectivity necessary to ensure a functioning aquatic system, including the protection of cold groundwater sources and riparian shading as necessary to the maintenance of cold water habitat.

Finally, as described above, staff's proposal to use percent saturation as a criterion by which to establish background DO conditions is based on the recognition of the inter-related nature of temperature and DO. Staff has taken this concept further than is typical in the regulatory arena by tying the calculation of percent saturation not to existing, potentially altered temperature but to estimates of temperatures under natural conditions. This ensures that the definition of background DO conditions as described by percent saturation protects both natural temperature and DO conditions as inter-related phenomena and results in actions specifically designed to improve stream temperatures, when necessary.

The TAC specifically recommended Table 2-2 (Oregon 1995) as the preferred DO criteria for the state of Oregon, including:

For the protection of salmonid spawning-- 11 mg/L as a 7 day mean[1] and 6 mg/L intergravel DO as a daily minimum
For the protection of other life stages of cold water species—8 mg/L as a 30-day mean[2]
For the protection of cool water species—6.5 mg/L as a 30-day mean
For the protection of warm water species—5.5 mg/L as a 30-day mean
To ensure no risk—no change from natural

[1] If conditions of altitude and natural temperature precludes achievement of 11 mg/L, then 95% saturation applies.

[2] If conditions of altitude and natural temperature precludes achievement of 8 mg/L, then 90% saturation applies.

Regional Water Board staff has also proposed 11 mg/L as a 7-day mean for the protection of spawning and incubation. Staff has further proposed a 9 mg/L daily minimum for the protection of spawning and incubation. This is intended to be comparable to the 6.0 mg/L daily minimum proposed by the TAC, as measured in the intergravel environment. Regional Board staff do not believe that the monitoring capabilities of the Regional Board and it's permitees yet allows for the accurate measurement of the intergravel environment without introducing potential risk of disturbance to incubating embryos and developing fry. Thus, a water column criterion was deemed more appropriate. As above, staff will re-consider the need to distinguish in the application of this criterion between waterbodies that are sediment impaired versus those that are not.

As provided by the TAC, staff proposes the application of percent saturation in lieu of concentration-based criteria if natural conditions prevent attainment of concentration-based criteria. Staff's proposal differs from that of the TAC, however, by considering any natural cause of criterion exceedance, not just conditions of altitude and natural temperature. Evidence on the Klamath River, as an example, illustrates that nutrient rich volcanic soils in the low gradient reaches of the upper basin have a profound effect on DO conditions many miles downstream into California, even in the absence of the economic activities (e.g., agricultural, forestry, mining), point source discharges, and dams.

Regional Water Board staff also proposes 8 mg/L mean for the protection of other salmonid life stages. Staff proposes the mean be measured as a 7-day mean, however, to provide greater protection to the threatened and endangered species found in the North Coast region. Staff will re-evaluate this proposal and consider whether the 30-day averaging period may provide adequate protection.

There is no "cool water species" category of beneficial use in the State of California. So, staff did not propose a specific water quality objective for this purpose. Staff did propose, however, a warm water mean criterion—6.0 mg/L as a 7-day average. This is somewhat more protective than the warm water protection suggested by the TAC; but, it adheres to the guidance offered by USEPA (1986). Staff will re-evaluate whether or not a 30-day averaging period is more reasonable than a 7-day averaging period.

Evaluating Criteria for the Protection of Freshwater Aquatic Life in Washington's Surface Water Quality Standards: Dissolved Oxygen

Similar to the approach in Oregon, the State of Washington convened a technical workgroup to evaluate the water quality criteria established to protect freshwater aquatic communities. The workgroup recommended to the Washington State Department of Ecology (WDOE) that it re-evaluate its existing criteria for dissolved oxygen. As with the State of Oregon and the North Coast Regional Board, the existing DO standards were given as single daily minima designed to protect different classes of waters, including a lake class in which "no change from natural levels" applies. Like in California and

Oregon, Washington's waterbody classes are divided by beneficial use; but, they are divided in a manner different from these other two states. Class AA streams are forested upland areas providing salmonid spawning, rearing and migration habitat. Class A streams are salmonid spawning, rearing and migration habitat found more broadly throughout the state. And, Class B streams are protected for salmonid rearing and migration, but not salmonid spawning.

Washington (2002) articulates as the challenge of selecting appropriate DO criteria, the two pronged phenomena of 1) human activities which ubiquitously affect DO conditions and 2) the presence of aquatic species (primarily salmonids) which benefit from DO conditions that are higher than what can often be held naturally in saturation. In consideration of these two opposing phenomena, Washington (2002) proposes DO criteria for individual species and life stages which are given as daily minima and 90-day averages of the daily minima. It further proposes that "when a waterbody's D.O. is lower than the criteria…and that condition is due to natural conditions or human structural changes that cannot be effectively remedied…, then human actions considered cumulatively may not cause the 90-day average of daily minima to decrease more than 0.2 mg/L." (Decision Memo-D.O., dated 12/10/02, page 6).

As assessed by Regional Board staff, this method of water quality protection allows for an unreasonable level of degradation from natural conditions for the following two reasons. First, it allows the degradation of natural conditions if the human-causes of that degradation are structural changes that cannot be effectively remedied. WDOE does not consider the benefits of off-site restoration, as an example, by which structural changes though not *remedied* could perhaps be *mitigated*. Second, it allows degradation of natural conditions by an amount (0.2 mg/L) which represents the limit of instrument accuracy for measurements less than 20 mg/L. But, rather than being applied to individual measurements of DO, as might be reasonable, it is applied to a 90-day average of those measurements. As such, changes to individual daily measurement of DO could be far more than 0.2 mg/L, if within a 90 day period DO recovery is sufficient to meet the average requirement. If the averaging period were on the order of 7- or 30-days, then this approach might be less worrisome. But, an averaging period of 90-days covers an entire season and could result in numerous days of inhospitable conditions during which fish succumb to multiple stressors, increasing, as an example, the risk of disease.

Washington (2002) includes an articulate and thorough literature summary in which studies are evaluated for:

1. Salmonid and non-salmonid incubation requirements,
2. Salmonid and non-salmonid juvenile acute lethality,
3. Salmonid and non-salmonid juvenile growth,
4. Salmonid and non-salmonid avoidance reactions,
5. Predation effects,
6. Salmonid and non-salmonid swimming speeds,
7. Macroinvertebrate species,
8. Synergistic effects,
9. Fluctuation versus constant oxygen regimes, and

10. Duration of exposure.

Staff agrees with the peer reviewer that Washington (2002) provides decision-makers with a detailed picture of the DO requirements of aquatic resources. In fact, Regional Board staff included Washington (2002) as a primary resource in its own literature review of salmonid habitat requirements, as published in Carter (2005).

Washington (2002) draws these conclusions from its literature review. They are similar to the insights provided by Carter (2005):

1. Any depression of oxygen from saturation will produce some reduction in the performance of fish.
2. Statistically significant changes to growth, swimming speed, etc. do not occur until oxygen levels are depressed to levels that are sometimes well below the saturation value.
3. Caution should be exercised when allowing even moderate reductions in oxygen.
4. Full protection implies that impacts to critical life-stages and processes will not reach levels that have a reasonable possibility of impairing the potential health of individuals or populations.

Washington (2002) makes these technical recommendations for the protection of salmonids:

1. ≥9.0-11.5 (30 to 90 day average of daily minima) during spawning through emergence. This assumes 1-3 mg/L will be lost between the water column and the incubating eggs.
2. No measureable change when waters are above 11 °C (weekly average) during incubation.
3. ≥8.0-8.5 (30 day average of the daily minima) and ≥5.0-6.0 daily minimum in areas and at time where incubation is not occurring to protect the growth of juvenile fish.
4. ≥8.0-9.0 (daily minimum) year-round in all salmonid waters to protect swimming performance.
5. ≥5.0-6.0 (daily minimum) year-round in all salmonid waters to protect against avoidance.
6. ≥3.9 (daily minimum) and ≥4.6 (7 to 30 day average of the daily minima) year-round in all salmonid waters to protect against acute lethality.
7. ≥8.5-9.0 (daily minimum or 1 day average) in mountainous headwater streams to protect macroinvertebrates.
8. ≥7.5-8.0 (daily minimum or 1-day average) in mid-elevation spawning streams to protect macroinvertebrates.
9. ≥5.5-6.0 (daily minimum or 1-day average) in low-elevation streams, lakes, and non-salmonid waters to protect macroinvertebrates.
10. ≥8.5 (1-day average) year-round in all salmonid waters to minimum synergistic effects with toxic substances.

Washington (2002) proposes salmon, steelhead and trout spawning and rearing standards of 7.0 mg/L as a daily minimum and 9.5 mg/L as a 90-day average of the daily minima.

These are somewhat less protective than those represented by the technical recommendations, both in terms of the numeric criteria and in the averaging period to which they are applied. It further proposes salmon, steelhead and trout rearing-only standards of 6.0 mg/L as a daily minimum and 8.5 mg/L as a 90-day average of the daily minima. The 8.5 mg/L standard is somewhat less protective than that represented by the technical recommendation because it is applied as a 90-day average rather than a 30-day average as per the technical recommendation. It is worth noting that Washington (2002) assumes 1-3 mg/L DO loss between the water column and intergravel environment and makes no distinction between sediment impaired and unimpaired waterbodies, as recommended by the Oregon TAC.

Comparatively, Regional Board staff proposes a salmonid spawning objective of 9.0 mg/L as daily minimum and 11.0 mg/L as a 7-day average. These are significantly more protective than the WDOE standards and are based on the assumption that an average of 3.0 mg/L DO is lost between the water column and intergravel environment. WDOE assumes a 1-3 mg/L loss and must have relied on the lower end of that range in establishing its water quality standards. Staff further proposes a salmonid rearing objective of 6.0 mg/L as a daily minimum and 8.0 mg/L as a 7-day average which is more comparable to WDOE's standards.

What differs significantly between WDOE's and Regional Board staff's proposals, is the way in which a natural conditions clause is applied. If a waterbody can not meet the life cycle DO requirements due to natural conditions, Regional Board staff proposes that natural background conditions apply. Staff proposes a method of estimating natural background conditions using percent saturation and *natural* temperature for the calculation. Staff proposes 85% saturation as representing the variation from full saturation that naturally occurs within a wide range of free-flowing river systems. For streams in which the variation from full saturation is less wide (e.g., 90% under natural temperature conditions), this approach provides a small allowance for degradation from natural conditions, an allowance which is ecologically acceptable as long as the stream in question is not otherwise an important refuge from temperature/DO impairment elsewhere in the basin. For streams in which the variation from full saturation is more wide (e.g., 80% under natural temperature conditions), this method provides no allowance for degradation from natural conditions so as to ensure protection of salmonids which can show stress when DO saturation is less than 85%. For any waterbody which does not reasonably fit within the model assumed by the proposed objectives, a site specific study can be conducted to develop more appropriate site specific criteria.

WDOE also allows an alternate DO criteria for waterbodies in which DO conditions are less than the ascribed life cycle requirements. However, WDOE allows alternate DO criteria when nonconformance is due to natural causes *and* due to irremediable human-caused structural changes. This approach reasonably recognizes the role of humans in the landscape and attempts to draw a line by which to identify those human activities for which regulatory authority should remain mute. From Regional Board staff's perspective, however, the line drawn unnecessarily ignores the possibility of *mitigation* as a tool for restoring aquatic conditions when legacy problems are irremediable. It also ignores the compliance schedule as a regulatory tool by which an entity can be given some length of time to study alternatives when current knowledge is inadequate to solve a problem.

Comment #18: Some aspects of the draft guidelines were over-explained and others required more detail. The health of nearly all aquatic animals is related to oxygen availability. The problem of acquiring sufficient oxygen is compounded by the fact that the physiological demands of aquatic fauna for oxygen increase dramatically as temperatures (and metabolic activity) increase. These points are of a "textbook" nature, and should for that reasons be briefly summarized in the North Coast RWCQB dissolved oxygen guidelines.

Response #18: A staff report to the Regional Water Quality Control Board is written to reach a broad audience, including the wider public. As such, staff often expounds on many seemingly "text book" concepts so as to ensure that those without a science education can understand and follow the issues, too. Staff has found that this contributes to a more productive public dialogue about staff's proposals, with less time lost due to poor science understanding.

In addition, a staff report is often designed to include the more technical aspect within the appendix, so as to accommodate the wider audience. In this case, Carter (2005) and USEPA (1986) form a large part of the scientific literature review associated with staff's proposals and are contained in the staff report as appendices.

Comment #19: In general, I am also concerned that most of the literature cited in support of the North Coast RWQCB dissolved oxygen guidelines is quite old. For example, the average paper on the DO requirements of salmonids cited in Carter (2005) was published more than 30 years ago (i.e. 1974 +/- 14 years). The salmonid requirements papers cited in the draft guidelines were just as old. Overall, nearly all of the archival studies cited on this topic were at least 20 years old.

Response #19: Carter (2005) was published by the North Coast Regional Water Quality Control Board in support of numerous actions facing the Board that affect salmonids, particularly work in the Klamath River watershed. Carter (2005) is not meant to be an exhaustive review of the scientific literature as it relates to the DO requirements of salmonid life cycle stages. But, it is meant to broadly capture the DO requirements of individual life cycle stages of functions as represented in the literature, particularly citing seminal field and laboratory studies. Other literature surveys such as Washington (2002) and Oregon (1995) provide additional, invaluable information upon which staff regularly draws.

In the Regional Board's effort to ensure that decisions are based on good science, staff submitted Carter (2005) for scientific peer review prior to its publishing. The peer reviewers were complimentary of the work and found it wholly acceptable. For the purposes of proposing revised DO objectives, staff concluded that USEPA (1986), Oregon (1995), Washington (2002), and Carter (2005) provided a perfectly adequate survey of the literature regarding salmonid DO requirements. As such, additional literature review was not conducted, except to answer very specific questions.

The peer reviewer should note that the salmonid requirements cited in the Chapter IV (Fisheries of the North Coast Region) are taken directly from Carter (2005) and cited as such. Thus, the issues the peer reviewer has with the age of studies cited by Carter (2005) are necessarily reflected in Chapter IV, as well.

Out of curiosity, staff has repeated the peer reviewer's analysis, including an assessment of Washington (2002) for comparison. Staff discovered that in Carter (2005) the publishing dates range from 1958 to 2002 with 1973 as the median date. The references included in Washington (2002), on the other hand, range from 1938 to 2002 with a median date of 1976. It appears that the age of the studies referenced in Washington (2002) are essentially the same as those referenced in Carter (2005). Staff believes the more important question regarding these literature surveys is whether or not the findings cited represent the current state of knowledge on the subject. As above, the scientific peer reviewers of Carter (2005) found it to represent sound science.

To lay this question to rest, staff will thoroughly review the findings of the literature surveys contained in Oregon (1995) and Washington (2002) to ensure that Carter (2005) has not missed some important aspects of the current science which should otherwise be considered in the development of this proposal.

Comment #20: I spent a short time searching the Web of Science, and in addition to recent review papers…, I found eleven studies published on the importance of intragravel DO for salmonids since the most recent paper cited in the North Coast RWQCB dissolved oxygen guidelines (i.e., Greig et al. 2007, Dumas et al. 2007, Heywood and Walling 2007, Malcolm et al. 2005, Merz and Setka 2004, Youngson et al. 2004, Meyer 2003, Soulsby et al. 2001, Geist 2000, Curry et al. 1995, Deverall et al. 1993). I don't think it is necessary for these guidelines to have an exhaustive review of the salmonid DO requirement literature, but much has been learned about salmonid IGDO (intragravel DO) related issues during the last decade and this new literature should be reflected in the draft guidelines.

Response #20: Thank you for bringing these papers to our attention. We will review them and ensure the findings represented by these papers are represented in the final proposal.

Comment #21: I am concerned that a blanket 3 mg/L correction factor will be overly protective in many cases, and under protective in the more important cases where IGDO availability really is a problem (for example if fine sediment loading is excessive). This 3 mg/L safety factor is apparently based on a 1965 Masters Thesis from Oregon State University via the 1986 USEPA DO guidelines. I find this rationale problematic since a great deal of research has been done on this topic in the intervening 44 years. For example, two excellent comprehensive review papers have been recently written on this topic (Greig et al. 2007, Jensen et al. 2009).

Response #21: Staff also find USEPA's (1986) reliance on a single Masters Thesis for the development of DO criteria to protect embryos and alevin of concern. This is the reason staff specifically highlighted the issue for peer review.

The peer reviewer makes an excellent point, as does the Oregon TAC that a 3 mg/L correction factor will be underprotective in cases where intergravel DO is impacted by excessive fine sediment. Please see Response #17 to TAC Recommendation #8 for further discussion of this matter.

Comment #22: From the literature it is clear that a myriad of factors influence the difference between IGDO and water column DO concentrations, the most important being the presence of fine sediments (and the organic content of these sediments) in the interstitial spaces of the gravel. Based on these reviews I suggest that instead of selecting a fixed safety factor to protect IGDO concentrations, which might be overly protective in some cases and underprotective in others, that a safety factor be determined on the basis of the fine sediment content of the spawning habitat in a particular river. In particular, I think this safety factor should be determined as a function of anthropogenically derived fine sediment.

Response #22: Thank you for this recommendation.

Comment #23: In general, North Coast RWQCB could adopt a 2 mg/L safety factor across the board and much more stringent safety factors when anthropogenic fine sediments are a concern. By basing these guidelines primarily on fine sediment, it will also make it much more likely that the root cause of large differences between water column DO and IGDO concentrations will be addressed. In general, I found the discussion of the IGDO issue had a weak scientific basis in the draft DO guidelines. In contrast, both the Oregon and Washington guidelines had more rigorous discussion of this topic. I think this aspect of the draft guidelines needs to be considerably updated and rethought in lieu of the modern literature (e.g., Greig et al. 2007, Jensen et al. 2009).

Response #23: Thank you for your suggestions on how to make more robust the discussion of intergravel DO requirements of salmonids. Staff will consider your recommendation of adopting a 2 mg/L safety factor. In addition, staff will review Oregon (1995), Washington (2002), Greig et al. (2007), and Jensen et al. (2009) in an effort to better articulate the issues associated with intergravel DO in the final staff report.

Comment #24: Figure 3 is merely the theoretical DO concentration at 85% saturation for a range of temperatures and elevations, so the "evidence" that background DO conditions can be approximated by 85% saturation is tautological. In my opinion, the draft guidelines do not present scientifically based evidence that the background DO levels can be approximated by 85 or 90% saturation. This evidence should be derived from actual data showing the distribution of DO saturation values typically observed during unperturbed natural conditions. I suggest the 5th or 10th percentile of these natural percent DO saturation distributions be used to represent minimum background DO levels. If this is done, it should be acknowledged in the new guidelines that by definition these minimum background levels will be violated with some regularity even in natural systems. But, the value in these "minimum standards" will manifest itself in cases where it is clear these minimum DO saturation levels are being missed significantly more often than expected based on "natural conditions." For example, if the minimum standard for percent DO saturation is set to the 5th percentile from undisturbed systems, and this minimum standard is violated significantly more often than 5% of the time in a system that is suspected to be impaired there would be unequivocal evidence of actual impaired beneficial use.

Response #24: Figure 3 is titled "Theoretical 85% D.O. Saturation at Standard Pressure (760 mm Hg) at Various Elevations" with the intention of indicating that the data contained in the graph represent theoretical values. Figure 3 and its companion Figure 2 are offered not as evidence that 85% saturation reasonably represents background DO conditions as interpreted by the peer reviewer, but as evidence that the existing background DO objectives as contained in Table 3-1 of the Basin Plan require updating. The staff report reads: "The third line of evidence that the background DO objectives require updating is based on an assessment of the theoretical DO concentrations possible within North Coast waterbodies at 100% and 85% DO saturation." Staff believes a misunderstanding of the text has led the peer reviewer to erroneously conclude the argument is tautological. Staff will revise the language of this section to reduce the risk of other's misunderstanding.

Section VI.3.2.2 provides a discussion of the use of percent saturation and natural temperatures to estimate background DO conditions and is based on the review of a basic stream ecology text, personal communication with a noted Fisheries Biologist, other water quality control plans within the State of California and the world, scientific studies, and the review of Oregon's DO criteria (Oregon 1995) by their Technical Advisory Committee. Staff agrees with the peer reviewer that a statistical analysis of DO distributions in unperturbed systems would provide far better "evidence" of the appropriate DO saturation value by which background concentrations can be calculated specifically for North Coast streams. Planning staff pursued this avenue with monitoring and assessment staff but were hampered by a dearth of historic DO data, particularly for unperturbed systems. In response to this comment, staff will pursue the following:

1. The identification of North Coast streams unperturbed by temperature alteration, flow alteration, nutrient enrichment, or historic excess sediment delivery.
2. The collection of new DO data in some reasonable subset of these streams.
3. The analysis of these data to determine the 5th percentile.

Comment #25: I will also point out that I suspect the "background DO objectives" presented in Table 2 (page 39) of the material provided to me, are also based on "rough estimates" and should be based on more rigorous data in cases where impairment might be of concern. Ideally, comprehensive datasets documenting "natural conditions" would be obtained prior to any signs of incipient impairment.

Response #25: The DO concentration values included in Table 2 (page 39) are the water quality objectives for DO contained in the North Coast Region's Basin Plan. As described in the text associated with Table 2, these site specific concentration limits were derived from two decades of monthly DO grab samples collected by a myriad of state and federal partners during the 1950s and 1960s. They represent the background conditions of that era. The point staff is attempting to make with Figure 2 and the associated text is that the existing background DO objectives are based on extensive sampling. But, because the data were collected as grabs during the day, they do not capture the diurnal fluctuation typically expected-- with DO minima observed during the night. In this modern era where datasondes are available to collect 24 hour data, the existing background DO objectives do not provide a reasonable baseline against which to compare.

Comment #26: The write up on pages 55-57 of the draft guidelines describing how "natural temperatures" might be estimated at a disturbed site were well thought out and scientifically based.

Response #26: Thank you.

Comment #27: The problem of non-attainment due to natural conditions needs to be strengthened considerably in the draft DO guidelines. As is extensively discussed in the Oregon and Washington DO guidelines and alluded in the North Coast region draft guidelines, in some cases it may be impossible to meet DO objectives for purely natural reasons. How will anthropogenic loading that negatively affects DO concentrations be managed in systems that are in non-attainment for natural reasons? This needs to be given careful consideration because in cases like this an absolute "no impact" standard will result in unreasonable outcomes. For example, if the standard is no impact, even recreational use (which could theoretically damage riparian vegetation or increase sediment and nutrient loading somewhat) would be excluded. The States of Oregon and Washington have dealt with this problem by setting the lowest allowable impact at 0.2 mg/L below saturation. In my opinion, this seems like a very reasonable approach and should be directly adopted by the North Coast RWQCB.

Response #27: The question raised by the peer reviewer is a matter of policy, not science. As such, it is not specifically relevant to the scientific peer review.

Please see the last few paragraphs of staff's response to Comment #17 for a discussion of the differences between staff's proposed natural condition clause and that of the State of Washington.

Comment #28: The personnel of the North Coast RWQCB should make a more concerted effort to define natural DO levels in the most important aquatic habitats of this region, in particular systems that are anthropogenically degraded or are naturally sensitive to DO stress…Surely considerable DO data has been archived during the last several decades and an effort should be made to extract the distribution of natural saturation levels from these data. In some cases, more DO data will be necessary to establish estimates of natural conditions for specific systems and this additional data should be collected when necessary. As previously noted, I am of the strong opinion that "natural conditions," as measured by typical percent DO saturation distributions for undisturbed waterbodies, should take precedence when establishing DO objectives for systems that are suspected to be impaired. Natural DO conditions should be established for a representative, but moderately small number of field sites within the region that are known to be minimally impaired at present. From these field studies of undisturbed systems, distributions of naturally occurring percent DO saturation levels could be established. These distributions could then be applied throughout the region.

Response #28: Please see Response #24.

Comment #29: I found the Washington State approach of classifying streams according to their "type of use" and level of protection for aquatic biota to be compelling model. Each waterbody in the North Coast region should be classified into one of the categories specified below and the DO in these systems managed accordingly. The RWQCB should be explicit as regards its intended beneficial uses for every major waterbody within the region, as well as all smaller waterbodies these standards are intended for, and as near as I could tell there was no mention of lakes whatsoever. This is problematic, as the types of DO standards that are most appropriate will depend greatly on the types of fish that are known to naturally occur in these systems. The DO guidelines need to more clearly state which types of waterbodies will be held to what DO standards.

For example, I suggest these categories for the North Coast region: critical habitat, salmon spawning habitat, salmon rearing habitat, cool water fish habitat, warm water fish habitat, lake habitat for salmonids, lake habitat for warm water fish, estuarine habitat. Based on what I have read I suggest the following long-term average DO standards:
General: all salmonid habitat will be considered in compliance if average DO exceeds 10 mg/L and IGDO is not adversely impacted by anthropogenic factors (e.g., fine sediment loading).
Critical habitat: no more than 0.2 mg/L below saturation
Salmon spawning habitat: no more than 0.5 m/L below saturation
Salmon rearing habitat: no more than 1.0 mg/L below saturation
Cool water fish habitat: no more than 2.0 mg/L below saturation
Warm water fish habitat: no more than 4.0 mg/L below saturation
Lake habitat for salmonids: not less than 7 mg/L on average in the hypolimnion
Lake habitat for warm water fish: not less than 4 mg/L on average in the hypolimnion
Estuarine habitat: not more than 1 mg/L below naturally occurring levels.
The seven day minimum standard shall be no less than 8 mg/L in any anadromous salmon bearing streams or rivers.

The standards above have the advantage of being simple so determining compliance is easy to monitor. Most of the standards above are relative to saturation, but in cases where the system is naturally below saturated oxygen levels, the standards should apply to the expected natural DO concentration. For example, along the west coast of the US, many estuaries are naturally below saturation because density stratification (due to freshwater inputs) and nutrient rich conditions along the entire coast naturally lead to moderately (and in some cases severely) hypoxic conditions.

Response #29: The State of California has adopted a system of beneficial uses similar but not identical to those adopted by the State of Washington. Individual waterbodies are designated beneficial uses based on the past or present uses of water. Please see Chapter II and Appendices A and B of the staff report for a review.

The proposed action associated with the staff report under peer review is the revision of the water quality objectives for DO, including objectives for individual beneficial uses. It does not extend to the issue of beneficial use designation; nor, does it contemplate the revision of the State's existing system. Staff believes the peer reviewer has strayed from the assigned task of reviewing the scientific basis for the proposed action.

Staff acknowledges the lack of comment in the staff report to the Region's lakes. A program of regulation for lakes is being developed for the Klamath River system under the Total Maximum Daily Load (TMDL). A section in the staff report will be added which described the approach under consideration in the Klamath and its broader implications for the rest of the region's lakes.

The exercise before staff is the development of numeric criteria protective of beneficial uses and the elaboration of the scientific basis for the recommended approach. The peer reviewer has recommended his own set of numeric criteria for DO. But, he does not provide the scientific basis for those recommendations, not even citations from which staff could substantiate his findings. This is problematic because staff can not propose that the Regional Board adopt any of the recommended criteria without a defensible scientific rationale.

The specific recommendations are further complicated by the fact that staff has seen very few studies (e.g., Davis 1975) that link DO saturation directly to salmonid health. This leads staff to wonder how the proposed criteria were developed. For example, what evidence is there that 0.5 mg/L DO less than saturation is adequately protective of salmonid spawning habitat? Does this water column limit adequately protect the DO conditions of the intergravel environment so critical to developing embryos and alevin?

Finally, the peer reviewer recommends the adoption of saturation-based DO criteria despite some compelling arguments against it. For example, the TAC responsible for reviewing Oregon's DO criteria argues that saturation criteria are comparable to concentration-based criteria in terms of protectiveness, only for spawning and embryo/alevin development. This is because the temperatures of the late fall through early spring are generally low enough to ensure relatively high DO during this period. The Oregon TAC, however, recommends against year round saturation criteria because the metabolic needs of the fish can easily outstrip the availability of DO as temperatures increase in the late spring through early fall. As discussed in the staff report, staff proposes the adoption of a saturation-based criterion that is calculated using an estimate of *natural* stream temperatures. This ensures that the DO concentrations associated with percent saturation are not unduly influenced by anthropogenically-elevated stream temperatures, particularly during the summer months.

Comment #30: Dissolved oxygen standards within a system should vary seasonally depending on the predominant use during that period of the year, e.g., a salmonid rearing standard during the summer months and a salmonid spawning standard during the fall and winter. The State of Washington compared data documenting the timing of

salmon/steelhead spawning to water DO data to derive their salmonid spawning standards for specific systems. This is an important consideration because many systems will always be within compliance during the colder months of the year, but might be out of compliance as spawning habitat during warm periods in the fall. These out of compliance periods need to be considered within the context of the proclivity of anadromous salmon to delay their spawning until water temperatures are favorable. For example, some salmon runs migrate into rivers before temperatures are favorable for spawning and wait until suitable conditions arise. If the DO standard is based on a particular DO concentration during for example late September this could be difficult to achieve certain years solely for climatic reasons. However, if the standard is relative to saturation as recommended above this would be much less of a regulatory problem. The literature which assesses the capacity of salmonids to delay spawning until favorable temperature conditions prevail should be reviewed and considered within the context of this particular issue. Failing the salmonid spawning DO objectives early in the spawning season when only a small proportion of the population has spawned is far less problematic than failing these objectives latter in the season after most fish have spawned.
Response #30: The peer reviewer raises an excellent point regarding the ability of salmon to delay the timing of migration and spawning to wait for favorable water quality conditions. Staff is familiar with the literature regarding this phenomenon. Staff's proposal is consistent with the idea that the onset of favorable water quality conditions for spawning varies over the years. This is because the life cycle based requirements to protect spawning are intended to be applied in those locations and during those times when spawning is or has historically occurred. This means that if fish do not enter a river until October 1st because prior to that date the water is too warm, the spawning criteria will be applied beginning on October 1st. Conversely, if fall rains are early and fish begin entering a river to spawn on September 15th, the DO criteria will apply at that time. At the behest of staff from USEPA, the staff report includes an estimated calendar period in which spawning and early development typically occur in North Coast streams. This all inclusive period is estimated to last from September 15 through June 6. Only for those waterbodies in which staff has little understanding of the actual timing of spawning and early development would this specific time frame apply; and, only until an assessment of site-specific timing could be conducted. With respect to his recommendation of a saturation-based criterion for spawning, the peer reviewer may not fully appreciate that reduced DO in the fall can be the result of anthropogenic activities, including loss of stream side riparian cover, summer water withdrawals for irrigation, nutrient-laden agricultural return flows, dams, channel braiding and widening due to sedimentation emanating from hillslope disturbance, etc. If one were to establish a DO criterion based on saturation as a way of protecting the onset of spawning, one would likely find widespread compliance with the criterion but site-specific locations of DO-related spawning impact. The primary goal in establishing water quality criteria is to prevent impact to beneficial uses.

Comment #31: When considering potential anthropogenic impacts on DO, equal consideration should be given to factors that might affect water temperatures (as this affects the concentration at which oxygen will be saturated), direct or indirect (via eutrophication) biochemical oxygen demand (as this affects whether DO saturation will be met), and fine sediment loading (as this affect IGDO exchange with the overlying water). For example, agricultural practices could impair riparian vegetation, as well as load warmer water, nutrients and sediments with return flows. If the temperature in a stream or river is increased due to damaged riparian habitat such that the concentration at which DO would be saturated declined by 1.5 mg/L, this system would be out of compliance even if it was saturated with DO. Similarly, if excessive erosion caused fine sediment to reduce IGDO 1.5 mg/L more than it would otherwise be, the system would also be out of compliance even if the overlaying water was in compliance. It is essential that the DO guidelines are designed to focus management attention of those factors that have the most direct impact on the DO limitations that will have the greatest impact in any particular system.

Response #31: Staff agrees completely. It is for this reason that staff propose life cycle-based criteria as the first tier of the program. If the ambient water quality conditions of a given waterbody do not provide DO conditions suitable to support salmonid life cycle requirements, then an assessment of the causes needs to be made. This might be done as part of compliance order issued to a specific discharger, including a schedule for studying the issue and achieving compliance. Or, it might be done as part of a watershed study conducted by the Regional Board in the form of a TMDL, as an example.

If the cause of noncompliance is determined to be associated with natural conditions, then the second tier requirements are applied. The second tier requirements are based on an estimate of natural background calculated by estimating natural temperatures and applying 85% DO saturation. As described in Response #17, for streams in which the variation from full saturation is less wide (e.g., 90% under natural temperature conditions), this approach provides a small allowance for degradation from natural conditions, an allowance which is ecologically acceptable as long as the stream in question is not otherwise an important refuge from temperature/DO impairment. For streams in which the variation from full saturation is more wide (e.g., 80% under natural temperature conditions), this method provides no allowance for degradation from natural conditions so as to ensure protection of salmonids which can show stress when DO saturation is less than 85%. For any waterbody which does not reasonably fit within the model assumed by the proposed objectives, a site specific study can be conducted to develop more appropriate site specific criteria.

Comment #32: One important detail that is never mentioned in the draft DO guidelines is the issue of climate change and how that might affect DO concentrations in some systems. Northern California is towards the southern end of the natural range for anadromous salmonids, especially inland of the fog-belt where summer air temperature can be quite high (>30 °C). This is particularly the case for inland areas of the Klamath/Trinity River system. It is well documented that the mean average temperature

in the Pacific Northwest region has increased by 1.0-1.5 °C during the last 50 years, and there is every reason to expect this rate of temperature increase will continue through the remainder of this century (Service 2004). How will warming of stream/river water solely due to this mechanism be treated vis-à-vis the DO standard? It is conceivable that a further warming of 1.5 °C could tip a number of systems in the North Coast region past the point of no return as it regards being viable salmonid habitat.
Response #32: Staff believes that the proposed water quality objective for DO is uniquely well-suited to deal with the effects of stream temperature increases resulting from global climate change. The first tier requirements are life cycle-based requirements taken from the scientific literature and designed to provide salmonid life cycle needs. If the ambient DO in a waterbody does not meet these life cycle requirements, then an assessment of the causes must be conducted. If natural conditions are found to be the cause of noncompliance, then an alternate DO criterion can be calculated. For the purpose of this objective, one could argue that the effects on ambient stream temperature from global climate change constitute a "natural condition." For such a waterbody, an alternate DO criterion is calculated using 85% saturation and an estimate of natural receiving water temperatures. In this example, the effect of global climate change could be included in the estimate of natural receiving water temperatures thereby resulting in a DO criterion that represents natural background conditions under the influence of global climate change.